# THE HISTORY OF THE *WORKS of the LEARNED.*

## *For* APRIL, 1740.

### ARTICLE XVII.

AN Account has been given, in two former Articles, of Dr. SMITH's *Compleat Syſtem of Opticks.* At the Cloſe of the latter of thoſe Articles, we promiſed a third, containing a Synopſis of Dr. JURIN's *Eſſay on diſtinct and indiſtinct Viſion.*

Dr. *Jurin*'s Entrance upon this Speculation was principally owing to ſome Hints and Obſervations in Dr. *Smith*'s Book, the greateſt Part of which he had by him in Print for ſeveral Years, and he was encouraged to purſue it thus far, as he ſays, by the admirable Facility of thoſe Methods of Computation, which Dr. *Smith* had deliver'd in that Treatiſe.

In the Beginning of this Eſſay, our Author ſhews what are the Conditions, what are the Requiſites, and which are the ſeveral kinds of *Diſtinct Viſion.* As to the *firſt* he ſays, " an Object is ſaid to be ſeen " diſtinctly, when its Outlines appear clear and

" well defined, and the Parts of it, if not too ſmall,
" are plainly diſtinguiſhable, ſo as that we can
" eaſily compare them one with another, in reſpect
" to their Figure, Size, and Colour."

*Secondly*, In order to ſuch diſtinct Viſion, it has hitherto, he ſays, been commonly thought, " That " all the Rays of a Pencil, flowing from a Phy- " ſical Point of an Object, muſt be exactly united " in a Phyſical, or at leaſt in a Senſible Point of " the *Retina*." He proves by divers Experiments, that this Opinion is without any Foundation. And he aſſures us, that to thoſe who ſhall make theſe Experiments with ſufficient Care, it will manifeſtly appear, " that ſometimes we have diſtinct Viſion, " when the Rays of each Pencil iſſuing from the " Object, are not accurately collected by the Eye, " into a ſenſible Point upon the *Retina*; and that this " ſort of diſtinct Viſion, without an exact Union " of the Rays, is not to be diſtinguiſhed, even by " an attentive Eye, from that other ſort of diſtinct " Viſion, where the Rays are the moſt accurately " collected into ſenſible, or even into Phyſical " Points."

*Thirdly*, The Species of diſtinct Viſion, which he has defined, are two, namely, Viſion perfectly diſtinct, or *perfect Viſion*, and Viſion imperfectly diſtinct, which in the Courſe of this Eſſay he uſually calls, ſimply, by the Name of *Diſtinct Viſion*.

" Viſion perfectly diſtinct, or *Perfect Viſion*, " is that, in which the Rays of a ſingle Pencil are " collected into a ſingle Phyſical, or ſenſible Point " of the *Retina*.

" Viſion imperfectly diſtinct, or ſimply, *diſtinct* " *Viſion*, is that, in which the Rays of each Pencil " are not collected into a ſenſible Point, but occupy " ſome larger Space upon the *Retina*, yet ſo as that " the Object is diſtinctly perceived.

" *Perfect*

" *Perfect Viſion*, in a given Eye, and a given " Diſpoſition of that Eye, depends only upon the " Diſtance of the Object. It has no Dependance " upon the Magnitude of the Object, except only " that it is requiſite the Object ſhould not be ſo very " ſmall, as on that Account not to be perceivable. " This excepted, at whatever Diſtance any one Ob- " ject is ſeen perfectly diſtinct, all other Objects do " likewiſe appear perfectly diſtinct.

" *Diſtinct Viſion*, in a given Eye, and a given " Diſpoſition of that Eye, depends upon this Di- " ſtance and Magnitude of the Object jointly."

The laſt Propoſition our Author evinces by ſome of the Experiments above mentioned; from whence it appears, that there is a real Difference between *perfect Viſion*, and what we call *diſtinct Viſion*. Hereupon he inquires particularly into the Reaſon, why an Object may be ſeen diſtinctly without *perfect Viſion:* For diſcovering of which, he firſt takes notice of the principal *Phænomena*, when Objects are confuſedly or indiſtinctly ſeen, and then examines into the Cauſes of thoſe Appearances. Under theſe Heads he takes an Occaſion of accounting for ſeveral *Phænomena* of the full Moon, of the new Moon, of the leſſer Planets, and of the fixed Stars; the Knowledge whereof is extreamly requiſite in Aſtronomical Obſervations.

Having conſidered *perfect* and *diſtinct Viſion* only upon the Foot of a given Diſpoſition of the Eye, in which Caſe he has ſhewn that perfect Viſion depends upon the Diſtance of the Object ſolely, and that *diſtinct Viſion* depends upon the Diſtance and Magnitude of the Object jointly, the Doctor applies himſelf in the next Place to conſider how either of theſe Sorts of Viſion may be procured by a Change in the Diſpoſition of the Eye. In the Proſecution of this Subject, he diſcuſſes the following curious Queſtions.

I. Whether *Perfect Viſion* in a given Eye is confined to one determinate invariable Diſtance, or may be obtained at different Diſtances by a Change in the Conformation of the given Eye.

II. Within what Limits theſe different Diſtances are comprehended, or what is the greateſt and leaſt Diſtance at which *Perfect Viſion* can be obtained in a given Eye, by changing its Conformation.

III. What is that Change, which is made in the Conformation of the Eye, in order to obtain *Perfect Viſion* at different Diſtances.

IV. By what Means Viſion, when it cannot be *Perfect*, is rendered *diſtinct*, or at leaſt not ſo indiſtinct as it would otherwiſe be.

V. What Change is made in the Eye, either by Habit or Cuſtom, or by our growing into Years.

VI. What is the leaſt Object, or Angle, that the Eye is capable of perceiving.

In the firſt of theſe Points all Authors, Dr. *Jurin* ſays, agree, except only the famous M. *De la Hire*; who ſuppoſes there is no accurate Collection of the Rays of a Pencil into a Point upon the *Retina*, that is, no *perfect Viſion*, unleſs when the Object is at ſome one determinate Diſtance ſuited to the Eye of the Obſerver. The others maintain, that the Diſtance of the Object may vary, and yet the Rays of a Pencil may be accurately united upon the *Retina*. The Experiment upon which M. *De la Hire* founded his Opinion, is briefly related in the 15th and ſome following Paragraphs of Dr. *Smith*'s Remarks upon his own Syſtem of Opticks; and the Inſufficiency of his Argument drawn from that Experiment is there fully ſhewn. The ſame thing has likewiſe been done by Dr. *Porterfield*, in the *Medical Eſſays* of *Edinburgh*. Dr. *Jurin* himſelf alſo has at leiſure Times, for ſeveral Years paſt, made a great Number of Trials, which have all turned

turned out to the Prejudice of M. *De la Hire*, and in Favour of the latter Concluſion.

With regard to the ſecond Point, *viz.* What is the greateſt and leaſt Diſtance at which *Perfect Viſion* can be obtained in a given Eye, by changing its Conformation, our Author ſays, The firſt of theſe Limits, or the leaſt Diſtance at which we can ſee with *perfect Viſion*, is eaſily ſettled. For beſides Dr. PORTERFIELD's Experiments, who determines it to be about ſeven Inches to his own Eye, we have the concurrent Experience of the generality of Perſons, who are at their full Growth, and whoſe Eyes are no ways impair'd by Age; for as much as in looking at minute Objects, as the Diviſions upon a *Gunter*'s Line, or thoſe of a diagonal Scale, for half an Inch, or in examining the Fineneſs of Linnen and Cambrick, or chuſing Lace, *&c.* they hold the Objects at 5, 6, or 7 Inches from the Eye. Whence it may reaſonably be preſumed, that the neareſt Diſtance for *perfect Viſion* is commonly 5, 6, or 7 Inches.

But as for the other of theſe Limits, or the greateſt Diſtance at which *perfect Viſion* can be obtained, the fixing it is a Matter of ſomewhat more difficulty.

This greateſt Diſtance is, by Dr. PORTERFIELD, determined for his own Eye to be 27 Inches. But that to the generality of Eyes this Diſtance is much greater, may reaſonably be preſumed from the Diſtinctneſs, with which we ſee a ſmall miſling Rain, when walking in a Piazza, or coming out of a Church, and within not leſs than ſix or eight Feet from the Door; or the ſmall Filaments of Silk, upon which Spiders tranſport themſelves thro' the Air, at a greater Diſtance; or the String of a Boy's Kite at a great Height in the Air.

Our Author points out a Way to find what this Diſtance is for a given Eye. The Inveſtigation of this Problem obliges him to conſider the Meaſures

of ſome of the Parts of the Eye. In theſe Meaſures he generally follows the famous M. *Petit*, * he having beſtowed more Pains upon the Examination of them than any other Writer; but he reduces them from the *French* Lines in which M. *Petit* has given them, to the Tenths of the *London* Inch, and Decimals of thoſe Tenths, following herein the Proportion eſtabliſhed by the ingenious Mr. *George Graham*, between the *London* Yard, and the half Toiſe of *Paris*, in ſome very accurate Meaſures that have been mutually exchanged between the *Royal Society*, and the *Royal Academy of Sciences* at *Paris*, namely that of 36 to 38, 355. He alſo aſſigns the Refraction of the aqueous Humour, as likewiſe of the *Cornea*, and the Proportion between the Sines of Incidence and Refraction, upon the Rays of Light paſſing out of the aqueous Humour into the Chryſtalline, and out of the Chryſtalline into the vitreous Humour: By computing upon theſe Meaſures and Refractions, he arrives at a deciſive Argument againſt M. *De la Hire's* Opinion.

Concerning the third Point, *viz.* What is that Change, which is made in the Conformation of the Eye, in order to obtain *perfect Viſion* at different Diſtances; Anatomiſts and Opticians, Dr. *Jurin* ſays, are divided into many Opinions, ſeveral of which he here propoſes, and briefly examines.

One Sentiment is, that the Eye in a State of Inaction, when both itſelf and the Parts about it are in perfect Reſt, is accommodated to ſee with perfect Diſtinctneſs at the greateſt Diſtance: And that in order to view nearer Objects, the Globe of the Eye is compreſſed by its Muſcles into an Oblong Figure, ſo as to render the Axis ſo much longer, as is

* Memoires de l'Acad. Royale 1728, 1730.

neceſſary

neceſſary to unite the Pencils into Points upon the *Retina*.

But to this Opinion it may reaſonably be objected, that in many Animals the *Sclerotica* is ſo hard, as not to be capable of changing its Figure by this Preſſure. And that even in Men and other Animals, where the *Sclerotica* is leſs hard, yet this Preſſure of the Muſcles can never be ſo equal as to affect the *Retina* alike in all Parts, but that its Fibres muſt in ſome Places be crouded cloſer together, or more preſſed inwards, than in others, which muſt needs diſturb the Viſion. To which we may add, that no ſlight Preſſure will be ſufficient for the Effect propoſed. In order to render Viſion perfectly diſtinct at all Diſtances, from 6 Inches to 14 Feet five Inches, it muſt be ſuch a Preſſure as will lengthen the Axis of the Eye one tenth Part; and to do this the *Retina* muſt be reduced from its ſpherical Figure, to ſuch an Oval as very much to diſorder the Range of its Fibres.

A ſecond Opinion is, that the Eye, when at reſt, is fitted for ſeeing the neareſt Objects diſtinctly; and that in order to diſtinct Viſion of remote Objects, it is preſſed againſt the Back of the Orbit, ſo as to render it flatter and its Axis ſhorter.

But againſt this *Hypotheſis* all the ſame Objections, as have been urged againſt the former, may juſtly be made.

A third Opinion is, that the Eye, when at reſt, is ſuited to the moſt diſtant Objects, and that in order to ſee the nearer ones diſtinctly, the Chryſtalline Humour is by Means of the *Ligamentum Ciliare* drawn forwards, ſo as to increaſe the Diſtance between its back Surface and the *Retina* ſufficiently to unite the Pencils into Points upon that Membrane.

But to ſee Objects with *perfect Viſion* from 14 Feet 5 Inches to 6 Inches, it would be neceſ-

ſary that the Cryſtalline ſhould be drawn forwards by about 0, 87, which the *Uvea* will not permit, there being no more than the Diſtance of 0, 22, at the moſt, between the *Uvea* and the Chryſtalline.

A fourth *Hypotheſis* is, that the Eye, in a State of Reſt, is accommodated to the neareſt Objects, and that in order to ſee diſtinctly the more diſtant ones, the *Ligamentum Ciliare* contracts, and thereby draws out the Chryſtalline into a leſs Convexity.

But to ſee Objects perfectly diſtinct from ſix Inches to 14 Feet five Inches, the Alteration in the Convexity of the Chryſtalline muſt be very great. For the Radius of each of its Surfaces muſt increaſe more than $\frac{2}{5}$ of what they are at preſent. But the Chryſtalline is of too firm a Texture, and the *Ligamentum Ciliare* ſeems much too weak, for ſo great an Effect to be expected.

A fifth Opinion has been advanced by the learned Dr. *Pemberton*, That in order to ſuit the Eye to the neareſt Objects, one Surface of the Chryſtalline is to be rendered more convex, while the other grows flatter, and that, to ſuit the Eye to the more diſtant Objects, one Surface of the Chryſtalline is rendered flatter, while the other becomes more convex. And this Alteration is ſuppoſed to be made by certain muſcular *Fibres*, within the Subſtance of the Chryſtalline.

This Sentiment has not, Dr. *Jurin* ſays, been ſo fully explained by the learned Author, as might be wiſhed. With regard to it, therefore, he only takes notice, that if the Eye is to be accommodated to near Objects, by rendering the anterior Surface of the Chryſtalline more convex, while the hinder Surface grows flatter, which for many Reaſons ſeems to be the moſt advantageous and convenient Method; then in order to ſee an Object with *perfect Viſion*, at a Diſtance of 5 or 6 Inches, the Radius of that anterior Surface muſt be leſſened from 3, 3081 to 2 nearly,

nearly, if the Radius of the hinder Surface be increaſed only from 2, 5056 to 3. And in order to ſee an Object with *perfect Viſion* at a Diſtance of 14 Feet 5 Inches, the Radius of the anterior Surface muſt be increaſed to 5 nearly, if the Radius of the hinder Surface be diminiſhed no more than to 2. So that while the hinder Radius changes from 3 to 2, the anterior Radius, in order to ſee perfectly at all Diſtances, from between 5 and 6 Inches to 14 Feet 5 Inches, muſt be more than doubled. But this ſurely is too great a Change, for a Subſtance of ſuch a Conſiſtence as the Chryſtalline Humour to admit of.

Our Author adds, that the Demonſtrations, upon which Dr. *Pemberton* founds his Opinion, are all built upon this Suppoſition, that in viewing Objects which appear confuſed, the Pupil is always contracted to the leaſt Size it is capable of: A Suppoſition that he afterwards proves contrary to Experience.

Meeting with no Satisfaction in any of the *Hypotheſes* above related, Dr. *Jurin* applied himſelf, as he ſays, to a diligent Conſideration of the Parts of the Eye, in order to find out, if poſſible, ſome Power or Powers ſeated within it, by which its Conformation may be ſo altered, as adequately to anſwer the Effects obſerved. Accordingly he has defined and very nicely deſcribed the *Cornea*, the *Uvea*, the *Chryſtalline Humour*, with the fine membranous *Capſula* that contains it, and the *Ligamentum Ciliare*. Upon this Foundation he goes on, to give a general Notion of the Manner, by which the Eye alters its Conformation according to the different Diſtances of Objects; and then, in order to ſhew that the Means he has propoſed are adequate to the intended Purpoſe, he enters into a more particular and demonſtrative Inveſtigation of the Subject.

With

With reference to the fourth Point, namely, By what means Viſion, when it cannot be *perfect*, is rendered *diſtinct*, or at leaſt not ſo indiſtinct as it would otherwiſe be, our Author apprehends it to be performed by two ſeveral Ways.

1. The firſt is for the Eye to apply the ſame Power, as it uſes to obtain perfect Viſion.

For inſtance, let us ſuppoſe the Eye to be in a State of Inaction, and conſequently ſuited to have *perfect Viſion* at the natural Diſtance of 15 Inches, and let any Object, as a Book of a ſmall Print, be placed within 4 Inches from the Eye, and the Eye be attentive to read it: Then immediately the *Cornea* will be rendered ſo convex, as to ſuit the Eye for ſeeing with *perfect Viſion*, at ſome Diſtance not leſs than five or ſix Inches, and by this Means the Viſion at four Inches, though it cannot be rendered perfectly diſtinct, yet will be leſs indiſtinct than it would otherwiſe be, and perhaps diſtinct enough to read the Book with eaſe.

Again, let another Object, as a Playhouſe Bill paſted againſt a Wall, be preſented to the Eye at the Diſtance of ſixteen Feet: Then as ſoon as we attempt to read this Bill, the anterior Surface of the *Capſula* will be rendred flatter, ſo as to accommodate the Eye to ſome Diſtance, not exceeding its utmoſt Limit of 14 Feet 5 Inches; and tho' by this Means Viſion at the Diſtance of 16 Feet cannot be rendered perfectly diſtinct, yet will it be rendered leſs indiſtinct than before, and perhaps diſtinct enough to read the Bill with eaſe.

For the fuller Illuſtration of this Matter, Dr. *Jurin* adjoins ſeveral Remarks, which bring him to the ſecond Way, whereby the thing here inquired after is to be effected, and that is,

2. The Contraction of the Pupil by the leſſer muſcular Ring of the *Uvea*. For by Art. 382 of Dr. *Smith*'s Opticks, the *Radius of Diſſipation* is,

*cæteris*

*cæteris paribus*, always proportional to the *Radius* of the Pupil. Conſequently, when the Pupil is narrower, the *Radius of Diſſipation*, and the *Penumbra* ariſing from the Diſſipation will be ſmaller, that is, Viſion will be rendered either diſtinct, or at leaſt leſs indiſtinct than it would otherwiſe be. Dr. *Jurin* here takes notice, that in a weak Light, the firſt of theſe Means, namely the altering the Convexity of the *Cornea*, or of the *Capſula*, muſt be uſed. For in ſuch a Caſe the Pupil is ſo far from contracting, that there is rather a Neceſſity of dilating it to take in more Light.

But in a ſtrong Light, the Contraction of the Pupil is chiefly made uſe of. For then that Contraction anſwers two Purpoſes; one to exclude an over great Quantity of Light, which would be offenſive to the Eye; the other to leſſen the Indiſtinctneſs. And when the Light is very intenſe, the Pupil may contract ſo much as of itſelf to cauſe *Diſtinct Viſion*, and to render the other Means altogether unneceſſary. So that theſe two ſeveral Means of procuring diſtinct, or leſs indiſtinct Viſion, may ſometimes be uſed jointly, that is, each in a moderate Degree, and ſometimes ſingly.

The Degree, to which the Pupil contracts, does not abſolutely depend either upon our Will, or upon the Senſation of Confuſion in the Object; but partly upon the Degree of Light. This is eaſily proved in the following Manner. By Day-Light take any Book, and ſtanding about the Middle of a Room, with your Back to the Window, hold the Book ſo near, as that the Letters may appear indiſtinct, and yet not ſo much, but that you can read, though with ſome Difficulty: Then turn your Face to the Light, and the Book will be read with more Eaſe. Again, holding the Book at the ſame Diſtance from your Eye, go into the darkeſt Part of the Room, and ſtanding with your Back to the Light, you will find

find the Book not at all legible: But upon coming to the Window, with your Face to the Light, you will be able to read, eſpecially if the Sun ſhines, with great Eaſe and Diſtinctneſs.

Alſo, a Perſon who has been oblig'd for ſome Years to uſe Spectacles in reading, will in the Sun-ſhine be able to read very eaſily without them.

Whence it appears, that in a ſtrong Light the Pupil contracts to a greater Degree, than it can be made to do by the Act of our Will, or by the Senſation of Confuſion only; conſequently it is a Miſtake to think, that upon ſeeing an Object confuſedly, the Pupil does always contract itſelf to the leaſt Size it is capable of.

With reſpect to the fifth Point to be examined into, *viz.* What Change is made in the Eye, either by Habit and Cuſtom, or by our growing into Years, Dr. *Jurin* ſays,

In the Eyes, as well as in all other Parts of the Body, the Muſcles by conſtant Exerciſe are enabled to contract themſelves with more Strength, and with more Eaſe, and to a greater Degree. And by diſuſing Exerciſe they are reduced to leſs Strength, and perform their Office with more Difficulty, and in a leſs Degree.

Alſo the elaſtick Parts of the Eye, like thoſe of the reſt of the Body, if they are often and long kept in Tenſion, do more eaſily obey that Tenſion, and do by Degrees loſe ſomething of their Elaſticity, ſo as not to be able to reſtore themſelves, or at leaſt not to do it with the ſame Readineſs, or to the ſame Degree, when the Tenſion ceaſes or abates: And if they are too ſeldom put in Tenſion, they grow ſtiffer, and are not ſo eaſily diſtended to the ſame Degree.

From theſe Cauſes, ſeem to ariſe thoſe Changes of the Eye, that Habit and Cuſtom introduce.

Perſons

Perſons who are much and long accuſtomed to view remote Objects, and but ſeldom to conſider near ones, ſee better at great Diſtances, and not ſo well at near Diſtances as other People.

This is often the Caſe of Travellers, Sailors, Sportſmen, *&c.* In them the *Ligamentum Ciliare* being much uſed, comes by Degrees to acquire more Strength, ſo as to draw out the *Capſula* of the Chryſtalline farther, and thereby to reduce it to a leſs Convexity than in other Perſons. Whence they are enabled to ſee diſtinctly at greater Diſtances than other Perſons.

But the *Capſula* being thus often put upon the Stretch, and long detain'd ſo, will thereby in Time loſe ſomewhat of its Elaſticity, ſo as not to return to its natural Convexity, when the Contraction of the *Ligamentum Ciliare* ceaſes. And this is one Reaſon, why thoſe Perſons do not ſee ſo well as the reſt of Mankind, at ſmall Diſtances.

Alſo, the greater muſcular Ring of the *Uvea*, by Diſuſe, will grow weaker, and the *Cornea*, by being ſeldom bent into a Convexity, will in Time grow ſtiffer, and leſs capable of obeying the Contraction of the muſcular Ring, which is another Cauſe why theſe Perſons do not ſee ſo well at ſmall Diſtances.

On the other hand, Perſons who are much and long accuſtomed to view Objects at ſmall Diſtances, as Students in general, Watchmakers, Gravers, Painters in Miniature, *&c.* ſee better at ſmall Diſtances, and not ſo well at great Diſtances, as the reſt of Mankind.

For in them the greater muſcular Ring of the *Uvea* contracts more eaſily and ſtrongly; and the *Cornea* more eaſily obeys the Contraction of that Ring: Whence they ſee better at ſmall Diſtances.

But the *Cornea*, by being thus often and long bent into a greater Convexity, does by Degrees

loſe

loſe ſomething of its Elaſticity, ſo as not to return to its natural Convexity, when the muſcular Ring ceaſes to act upon it: This is one Cauſe of their not ſeeing ſo well at great Diſtances.

Alſo, the *Ligamentum Ciliare*, being ſeldom employed to leſſen the Convexity of the *Capſula*, does by Degrees become leſs capable of performing that Office. And the *Capſula*, being ſeldom drawn out and put into Tenſion, muſt loſe ſomething of its diſtenſile Quality, ſo as leſs eaſily to comply with the Action of the Ligament. And this is another Cauſe of their not ſeeing ſo well at great Diſtances.

Perſons who begin to uſe Spectacles early, and keep conſtantly to the Uſe of them, do in a little Time find themſelves under a Neceſſity of continuing to uſe them. For by uſing Spectacles, they have not Occaſion to contract the greater muſcular Ring, to bend the *Cornea*, ſo much as before, and when they have forborne this Contraction for ſome Time, they are not ſo well able to perform it, as before they uſed the Spectacles.

In Children the Pupil is uſually more dilated than in grown Perſons. This is eaſily ſeen; for in grown Perſons the Diameter of the Pupil ſeldom appears equal to the Breadth of the Ring of the *Uvea*, on either ſide of it, that is, is ſeldom equal to one Third of the Breadth of the *Cornea*, and is often much leſs, eſpecially in a good Light. But in Children the Diameter of the Pupil ſcarce ever appears ſo little as one third of the Breadth of the *Cornea*, and often exceeds half that Breadth.

The Reaſon of this, Dr. *Jurin* apprehends to be, that in Children the *Cornea* is extreamly flexible, ſo as to be very eaſily bent by its muſcular Ring, into any Curvature that is neceſſary for ſeeing diſtinctly in Reading, and conſequently their Pupil has leſs Occaſion to contract for *Diſtinct Viſion*.

But

But in grown Perſons, the *Cornea* is ſomewhat ſtiffer, and does not ſo eaſily bend, whence they have Occaſion more frequently to contract the Pupil.

And in elderly Perſons the *Cornea* grows ſtill more rigid, ſo that they can hardly read without Spectacles, unleſs the Print be very large, or the Light be very ſtrong, ſo as to cauſe a great Contraction of the Pupil. It is for this Reaſon they are obliged to hold the Candle between the Eye and the Paper they read; and their doing ſo is a certain Sign that they begin to want Spectacles.

Our Author obſerves further, that Children read much nearer than grown Perſons. This happens for two Reaſons.

1. Their Eyes are ſmaller, and the leaſt Diſtance any Eye can ſee diſtinctly at, is proportional to the Length of the Eye.

2. Their *Cornea*, being very flexible, is eaſily accommodated to a leſs Diſtance. And at a leſs Diſtance the Print appears larger, and is eaſier to read, than at a greater.

Elderly Perſons ſee better at a great Diſtance, than younger People. — The Cauſe of this has been reckoned to be the ſhrinking of the Coats and Humours of the Eye. But this Dr. *Jurin* thinks a Miſtake. For if the Eye, he ſays, were to ſhrink in all Parts proportionably, this would have a contrary Effect, the Eye would then become ſhort-ſighted, as has been obſerved of Children, whoſe Eyes are ſmaller than thoſe of Men. But the true Reaſon he takes to be this. The *Cornea*, as it is of a rarer Texture, and is more expoſed to the Air than the *Sclerotica*, will in length of Time ſhrink a little more than the *Sclerotica*, and will by that Means grow a little flatter than it was before. ——

Our

Our Author has made ſeveral other curious Remarks relating to this Point, which for brevity ſake I paſs over, that I may have Room for a few of thoſe which fall under the ſixth and laſt Head of his Inquiry, *viz.* What is the leaſt Object, or Angle, that the Eye is capable of perceiving.

Dr. HOOKE aſſerts, that when an Object ſubtends a leſs Angle than a Minute, it is to the generality of Eyes, wholly inviſible. And from ſome Experiments Mr. *Jurin* is inclined to think, that when the Object is round, as a black circular Spot upon a white Ground, or a white Spot upon a black Ground, an Eye muſt be exceeding good to perceive it under an Angle much leſs than a Minute.

But there are other Caſes, in which a much leſs Angle can be diſcerned by the Eye, ſome of which he conſiders, after premiſing one Obſervation which is neceſſary for explaining the Reaſons of them. The Obſervation is this,

" In order to our perceiving the Impreſſion " made by an Object upon any of our Senſes, the " Impreſſion muſt be either of a certain Degree of " Force, or of a certain Degree of Magnitude.

For Inſtance, a very ſmall Drop of Dew, or Rain, may fall upon the Hand without our feeling it wet; and a very ſmall Particle of Sugar may be laid upon the Tongue without our taſting it ſweet; but a Spark of Fire of the ſame Magnitude with the Drop of Rain, by falling upon the Hand, ſenſibly affects it, becauſe the Impreſſion of the Spark of Fire is of a greater Force than that of the Drop of Water, or Particle of Sugar.

And for the ſame Reaſon, a Star, which appears only as a lucid Point through a Teleſcope, not ſubtending ſo much as an Angle of one ſecond, is viſible to the Eye, though a white or black Spot of 25 or 30 ſeconds is not to be perceived.

Alſo

Alſo, though one very ſmall Drop of Water will not ſenſibly affect the Hand, yet a Number of ſuch ſmall Drops falling together, or one large Drop falling alone, will affect the Hand with a Senſe of Wet, becauſe the Quantity of the Impreſſion is greater.

And for the ſame Reaſon, a Line of the ſame Breadth with a circular Spot, will be viſible at ſuch a Diſtance, as the Spot is not to be perceiv'd at, becauſe the Quantity of Impreſſion from the Line, is greater than the Quantity of Impreſſion from the Spot. And a longer Line is viſible at a greater Diſtance, than a ſhorter Line of the ſame Breadth.

It has been by ſome Perſons ſuppoſed, that the Impreſſions of viſible Objects, are receiv'd upon certain *Villi* of the Optick Nerve, imagined to ſtand erect upon the *Retina*, like the Pile on Velvet. And from the Experiment that a Spot leſs than one Minute in Diameter cannot be perceived by the Eye, it would follow that the Thickneſs of one of thoſe *Villi* is about $\frac{1}{5000}$ or $\frac{1}{6500}$ Part of an Inch.

But admitting the Suppoſition, the Diameter of one of theſe *Villi* will be experienced to be much ſmaller. For Dr. *Jurin* found, that a Bit of Silver Wire, of the Thickneſs of $\frac{1}{485}$ of an Inch, laid upon a white Paper, is viſible at the Diſtance of 10 Feet. Hence the Angle ſubtended by the Diameter of the Wire is about $3''\frac{1}{2}$. Conſequently, the Thickneſs of a *Villus* muſt be 17 times ſmaller than is above aſſign'd. The Doctor took a ſingle Filament of Silk, and laid it cloſe to this Bit of Wire; then viewing them with a deep magnifying Glaſs, he judged the Diameter of the Wire to be equal to 4 Diameters of the Silk. The Diameter of the Silk muſt therefore be about $\frac{1}{1940}$ Part of an Inch. This Silk and Wire being laid upon a white Paper, were both viſible at the Diſtance of 40 Inches from the Eye, and the Silk appeared plainly leſs than the Wire.

Here the Silk ſubtended an Angle of $2''\frac{1}{2}$ only. Conſequently, the Thickneſs of a *Villus* is 24 times ſmaller than that firſt above determined. ———

There are under the Head, we are now upon, divers other Obſervations, which our Author employs in the Illuſtration of it, that may afford the curious Reader ſome Entertainment. Thus he takes notice,

The more compounded any Object is, or the more Parts it conſiſts of, it will, *cæteris paribus*, be more difficult for the Eye to perceive and diſtinguiſh its ſeveral Parts. For inſtance, it is ſomewhat difficult for the Eye to judge how many Figures are contain'd in the following Numbers, 1111111111; 1000000000: But if we divide the Figures in this Manner, 11111, 11111; 100000, 0000; ſo as to conſtitute ſeveral Objects leſs compounded, we can more eaſily eſtimate the Number of Figures contained in each of thoſe Numbers; and more eaſily ſtill, if we thus divide them, 1, 111, 111, 111; 1, 000, 000, 000.

The Cauſe of this, Dr. *Jurin* apprehends, is the Difficulty of keeping the Eye perfectly ſteady. For in counting theſe Figures, 1111111111, if the Eye be arriv'd, for Inſtance, at the fifth Figure from the Right-hand, and by any imperceptable Motion of the Body, or involuntary Fluctuation of the Eye itſelf, its Axis happens to be directed to the Fourth or Sixth Figure, or to the Interval between the fifth Figure, and either of theſe, we find ourſelves immediately at a Loſs, not knowing from which Figure to proceed in our counting, and are therefore oblig'd to begin again at the Right-hand.

That this is the true Reaſon, may appear from its being eaſier to count the Figures in the Number 121212121212, than in the Number 111111111111; and from its being ſtill eaſier to count

count them in the Number 123123123123 or 123412341234, where, from the Diſſimilitude of the Figures, the Eye more eaſily recovers its Place when once loſt.

From the ſame Cauſe of the Inſtability of the Eye it muſt be, *cæteris paribus*, more difficult to perceive and diſtinguiſh the Parts of any compound Object, when each of thoſe Parts ſubtends a very ſmall Angle, than to ſee a ſingle Object of the ſame Magnitude as one of thoſe Parts.

For Inſtance, the Hour 1. upon a Dial-plate, may be ſeen at ſuch a Diſtance, as the Hours 11, 111, 1111, are not to be diſtinguiſhed at, eſpecially if the Obſerver be in Motion, as in a Coach, or on Horſe-back, or even in a Boat upon the Water. This may eaſily be experienced in looking at a Dial, where the Intervals between the Black or Gilt Strokes, are equal to the Breadth of thoſe Strokes; and much more eaſily where the Intervals are of a leſs Breadth.

Our Author makes many other ingenious Remarks upon this Subject, in the Courſe of which he has taken an Occaſion of defending the Accuracy of the celeſtial Obſervations of the famous HEVELIUS, againſt a principal Objection made thereto, by our celebrated Countryman Dr. HOOK.

He has likewiſe reſolved a very difficult Queſtion propoſed by Mr. *Huygens* in his *Syſtema Saturnium*, *viz.* Why the outer Edge of *Saturn*'s Ring is not viſible in the Form of *Brachia*, when the Earth is in the Plane of the Ring? *Saturn* then appearing Round.

This Mr. *Huygens* found no other Way of ſolving, than by ſuppoſing that this outer Edge is of ſuch a Nature, or is covered with ſuch a Matter, as does not at all, or very little, reflect the Light that falls upon it from the Sun; and in this Suppoſition he has been followed by ſome later Philoſophers.

Now, as Dr. *Jurin* ſays, it has indeed been obſerved by Mr. *Huygens* himſelf, as well as by Signor *Caſſini*, and ſome of our *Engliſh* Aſtronomers, that the outer Part of the Planes of the Ring is leſs luminous, than the inner and brighter Part of thoſe Planes, or even than the Body of *Saturn*, which is ſomething darker, at leaſt towards the Out-ſide, than the inner and more lucid Part of thoſe Planes.

But that this outer Edge ſhould be of ſo different a Nature from thoſe Parts of the upper and under Plane between which it lies, and to which it is immediately contiguous, as that thoſe ſhould reflect the Light in the Manner they are found to do, and this ſhould reflect it very little, or not at all, is difficult to ſuppoſe.

It may therefore be worth while, our Author ſays, to try, whether this Queſtion can be anſwered any other Way, without admitting ſo hard a Suppoſition.

Mr. *Huygens* ſuppoſes the Thickneſs of the Ring to be about 600 *German* Miles, and as he makes the Diameter of Saturn equal to 15 Diameters of our Earth, which is about 2000 *German* Miles over, this Thickneſs of the Ring muſt by his Eſtimate be about $\frac{1}{50}$ Part of the Diameter of *Saturn*.

Now the apparent Diameter of *Saturn*, by the Obſervations of the late accurate Aſtronomer, Mr. *James Pound*, is, at his mean Diſtance from the Earth, 18″; therefore at his leaſt Diſtance it muſt be 20″, and conſequently the greateſt apparent Thickneſs of the Ring muſt be eſtimated at $\frac{1}{50}$ Part of 20″, when the Earth is in the Plane of the Ring.

And if the Teleſcope uſed by Mr. *Huygens* in theſe Obſervations did, as he ſuppoſes, magnify an hundred times, the apparent Thickneſs of the Ring through that Teleſcope muſt have been at the moſt $\frac{20}{50}$″ × 100, that is 40″. Now

Now we conceive that in ſuch a compound Body as *Saturn*, appearing under an Angle of 20″ × 100, or of 33″, that is, about the Size of the full Moon, with two *Brachia* proceeding from him of 40″ in apparent Breadth, thoſe *Brachia* cannot be very diſtinguiſhable, even though they were to reflect the Light as ſtrongly as the Body of the Planet; much leſs, if they are not ſo luminous as the Planet. And leſs ſtill can thoſe *Brachia* be viſible, if when the Sun is in the Plane of the Ring, the Earth be in Quadrature with him and *Saturn*; in which Caſe the Edge of the Ring, being obliquely ſeen, will ſubtend an Angle at the Eye leſs than 40″ thro' the Teleſcope.

But if the Breadth of this Edge be much leſs than $\frac{1}{10}$ Part of *Saturn*'s Diameter, as will appear probable from what follows; then it muſt have ſubtended a much leſs Angle in M. *Huygens*'s Teleſcope than 40″, ſo that the *Brachia* muſt undoubtedly be inviſible, and *Saturn* ought to appear round, as he is found to do by Obſervation.

It may be here objected, that in the Year 1656, Mr. *Huygens* ſaw the Projection of this Edge as a dark Liſt upon the Body of *Saturn*, at a Time when the Earth and Sun were both nearly in the Plane of the Ring; and conſequently that the Thickneſs of the Ring is not ſo ſmall as to render it inviſible.

Dr. *Jurin* anſwers, there is Reaſon to ſuſpect this illuſtrious Aſtronomer was miſtaken, not in the Obſervation itſelf, but in the Judgment he made upon that Obſervation.

That he ſaw a dark Liſt traverſing the Middle of the Planet, is not to be doubted; but as a like dark Liſt, or Belt, has ſince been diſcover'd about the Middle of *Saturn*, at ſuch Time as the Earth is out of the Plane of the Ring, ſo that the Ring is plainly viſible, and the Middle of *Saturn* appears

within the Ellipſe, we ſuſpect that this Appearance, or ſuch Part of it as was moſt diſtinguiſhable thro' his Teleſcope of 23 Feet, either alone, or jointly with the darkiſh Line, ariſing from the Projection of the Edge of the Ring upon the Body of *Saturn*, might be miſtaken for the Projection of that Edge alone; which muſt cauſe him to conclude the Thickneſs of the Ring much greater that it really is.

And when the Earth and Sun were not exactly in the Plane of the Ring, but one was a little elevated above it, and the other a little depreſs'd below it, or both were either a little elevated above it, or a little depreſſed below it, and yet ſo little that the Plane of the Ring was very faintly illuminated by the Sun; in all theſe Caſes, that Plane of the Ring, which was expoſed to the Eye of the Obſerver, would be projected upon the Body of *Saturn* as a narrow dark Liſt, contiguous to the narrow dark Liſt formed by the Projection of the outer Edge of the Ring. And theſe two narrow dark Liſts muſt appear as one, and might be taken by Mr. *Huygens* for the Projection of the Edge alone; which conſequently muſt have been reckoned much thicker than it really is. To which it muſt be added, that when the Earth and Sun were on oppoſite Sides of the Plane of the Ring, or when both being on the ſame Side, the Earth was a little more, or a little leſs out of the Plane than the Sun, in both theſe Caſes the Eye might perceive a ſmall Part of the Shade caſt by the Ring upon the Body of the Planet, which being contiguous to the other two narrow dark Liſts, would appear as one with them, and muſt increaſe the Error.

But it may be farther objected, our Author ſays, that when *Saturn* appears with *Brachia*, or even with *Anſæ*, in which Caſe the ſame Side of the Ring is turned to the Earth, as is illuminated by the Sun,

Sun, yet ſuch a dark Liſt has been obſerv'd traverſing the Body of *Saturn* ſometimes on the Northern Part, and ſometimes on the Southern, but always in ſuch a Poſition as anſwers to the Projection of the Ring upon the Body of the Planet, and conſequently ariſing only from that Projection.

To this he anſwers, that the outer Part of the Plane of the Ring, which, according to what is ſaid above, in all probability is equally dark with the Edge of the Ring, will be projected upon the Body of *Saturn*, contiguous to the Projection of that Edge, and together with it will form the Appearance of one dark Liſt.

To which we may add, that when the Eye is any thing leſs elevated than the Sun about the Plane of the Ring, ſome Part of the Shadow muſt appear contiguous to the two Projections above mention'd, and muſt increaſe the Breadth of the Liſt.

Conſequently, what was obſerved in this Caſe by Mr. *Huygens*, was not the Projection of the Edge alone, but the united Projection of that Edge, and of the outer and darker Part of the Plane of the Ring, to which ſometimes a Part of the Shadow might be added: So that the Ring may be much leſs in thickneſs than $\frac{1}{50}$ Part of *Saturn*'s Diameter, and might ſubtend a much leſs Angle than 40″, when magnified an hundred times thorough the Teleſcope.

There is another curious Queſtion that Dr. *Jurin* reſolves under this Head, *viz.* Why the Moon's Edge appears even, and not ragged? He ſays,

When *Galileo* publiſhed his new Diſcovery of the Inequality of the Moon's Surface, and aſſerted all the brighter Parts of it to be full of high Mountains, a great Number of learned Perſons objected, that if it were true as he ſuppoſed, The Moon's Limb, which is generally very bright, would be ſo far from appearing even and ſmooth thro' the Teleſcope, that

it would look ragged like the Teeth of a Saw, or a Wheel in Clock-work.

To which that moſt acute and ingenious Philoſopher replied, that one Range of Hills only upon the very Edge of the Moon might create ſuch an Appearance as they ſuppoſed; but that ſeveral Ranges of Hills being placed one behind another; the Tops of the nearer Hills muſt be projected by the Eye into the Apertures or Vallies between the Hills of the outer Ranges, and conſequently muſt cauſe the Limb of the Moon to appear even, as it is found by Obſervation.

To this it may be added, that if there were only one Range of Hills on the Edge of the Moon, and the Height of thoſe Hills were about $\frac{1}{1000}$ Part of the Moon's Diameter, as *Galileo* ſuppoſes in another Place, then, the Moon's apparent Diameter being about 30′ or 32′, the perpendicular Height of thoſe Hills, which alone is here to be conſidered, would be preſented to the naked Eye, under an Angle of $\frac{3}{100}$ or $\frac{32}{1000}$ of a Minute, and thro' his Teleſcope, magnifying about 30 times, would be preſented under an Angle of $\frac{9}{10}$ or $\frac{96}{100}$ of a Minute, which in ſuch a compound Object could hardly be diſcerned: Much leſs could the ſmaller Inequalities, which muſt be formed by ſeveral Ranges of Hills, be viſible thro' his or a much longer Teleſcope.

In accounting for the *Phænomena* of indiſtinct Viſion, Dr. *Jurin* has made uſe of only this ſingle Principle, That the Rays of a Pencil are not accurately collected into a Point upon the *Retina*, but occupy a circular Space thereon, which he calls the *Circle of Diſſipation*. This Circle he has hitherto treated of, as if it were uniformly luminous, or as if the Rays of the Pencil were equally and uniformly ſpread over the whole Circle. But in reality,

as he tells us, the Fact is otherwiſe: The Rays are not evenly diſpoſed all over this Circle, but are denſer in ſome Parts of it than in others. And tho' in many Caſes, and indeed in moſt of the *Phænomena* he has related, this Inequality of the Denſity of the Rays is not very conſiderable, nor occaſions any great Change in the Appearance, yet there are ſome few of them that will be remarkably affected by it; and there are ſome other very uncommon and ſurpriſing Appearances, that, he tells us, are not to be accounted for from the common Laws of *Opticks*, and depend wholly upon this Inequality of the Rays in different Parts of the *Circle of Diſſipation*.

Several of theſe remarkable Appearances our Author has diſtinctly deſcribed: All which he ſuppoſes to be only different Caſes, or Varieties, of one and the ſame *Phænomenon* diverſified by different Circumſtances, and to ariſe from one and the ſame Cauſe.

This Cauſe he inquires into, and inveſtigates. He ſhews that aſſigned by M. *De la Hire* to be intirely inſufficient for their Solution. That which he propoſes is no imaginary or precarious Fiction, but has been evidently proved to exiſt long before thoſe Appearances were taken notice of. In a Word, it is no other, as he evinces, than thoſe amazing Diſpoſitions of the Rays of Light, which Sir *Iſaac Newton* diſcovered and demonſtrated them to be endued with, and which he calls their *Fits of eaſy Refraction*, and *Fits of eaſy Reflection*. How the *Phænomena* in queſtion are hereby produced our Author very largely and clearly ſets forth.

In making the Experiments from which he has deduced his Concluſions relating to this Subject, an extraordinary Appearance preſented itſelf to our Author.

" In

" In looking at the Confines of a dark and a " lucid Surface ſeen by indiſtinct Viſion, there will " ſometimes appear on the Border of the lucid " Surface, without the utmoſt dark Line of the " Image, a Line of ſome Breadth much more lumi- " nous than the reſt of the lucid Surface. And on " the Border of the dark Surface, within the utmoſt " lucid Line of the Image, will appear a Line of " ſome Breadth much darker than the reſt of that " Surface."

This Appearance he at firſt imagined to proceed from the ſame Cauſe, as the other *Phænomena* we have been ſpeaking of, namely the *Viciſſitude* of the *Fits of eaſy Refraction* and *eaſy Reflection* in the Rays of Light; but finding no way of accounting ſatisfactorily for it from that Cauſe, he ſuſpected ſome Miſtake, and therefore applied himſelf to conſider it more attentively. The Doctor has ſet down the Steps by which he proceeded in his Examination.

Theſe led him to reflect upon ſome like Appearances he had met with before, either from his own Obſervation, or the Relation of ſome of his Acquaintance, and to judge that both the one and the other muſt proceed from a different Cauſe than what he had hitherto ſuppoſed. Theſe Obſervations of his own and his Friend's are as follow:

1. A Perſon ſitting to be ſhaved againſt a light ſaſh Window, fixed his Eyes intently for ſome time upon the Window, and afterwards ſhutting them, he had now the Appearance of a Window ſimilar to that he ſaw before; only the Glaſs Panes were dark, and the Wood between them was luminous.

Another fixed his Eyes for ſome time upon the End of his Pen black with Ink, and held againſt white Paper; and upon ſuddenly moving his Pen, without ſtirring his Eyes, he ſaw the Appearance of

of a bright luminous End of a Pen, upon the ſame Part of the Paper. And ſince our Author was told of this Appearance, he has often made the ſame Obſervation.

In looking at the ſetting Sun, in a Coach upon the Road, when the Light is not ſo ſtrong as much to offend the Sight, if the Eyes be ſuddenly directed to a diſtant Part of the Sky, we have the Appearance of one, two, three or more dark Circles of about the ſame ſize with the Sun, upon different Parts of the Sky.

A Perſon conſidering the Reaſon of the vaſt Length of the Image of the ſetting Sun ſeen by Reflection from the *Thames*, looked ſo long upon it, that when he took off his Eye, every thing appear'd to him with a long dark Beam upon it for a quarter of an Hour.

Another, after looking too long at the Sun eclipſed, ſaw a dark Spot upon every Thing for ſeveral Months after.

Theſe, and many more *Phænomena* of a like kind, ſeem, our Author ſays, to depend upon this Principle, "That when we have been for ſome Time affected with one Senſation, as ſoon as we ceaſe to be ſo affected, a contrary Senſation is apt to ariſe in us, ſometimes of itſelf, and ſometimes from ſuch Cauſes, as at another Time would not produce that Senſation at all, or at leaſt not to the ſame Degree."

Every-body knows, that the ſudden Ceſſation of intenſe Pain after ſome Continuance, is immediately follow'd with ſenſible Pleaſure.

In coming out of a ſtrong Light into a Room, with the Window-ſhutters almoſt cloſed, we have immediately a Senſation of Darkneſs; and this continues much longer than the Pupil requires to dilate and accommodate itſelf to that weak Degree of Light, which is almoſt inſtantly done.

But

But after ſtaying ſome time in a much darker Place, the ſame Room which appear'd dark before, will be ſufficiently light.

If we drink a diſh of Coffee, or Tea, without Sugar, and afterwards taſte of another Diſh with but little Sugar in it, this laſt will appear very ſweet.

But if we firſt eat any thing very ſweet, a Diſh of Coffee, or Tea, moderately ſweetened, will taſte very bitter; and it were eaſy to bring a great number of like Examples.

But ſuch a Change of Senſation is not always general, ſo as that the whole Organ of our Senſes is affected by it: It is oftentimes partial, ſo that from one and the ſame Cauſe one Part of the Organ undergoes a Change of Senſation, while the other Part perceives no Change.

For inſtance, the Skin of our Bodies, to ſpeak looſely, may be conſidered as the whole Organ of Feeling, with reſpect to the Heat and Cold we are environed with, or of the Water we may happen to be immerſed in: and the whole *Retina* may be conſidered as the Organ of Sight.

But when we are in a moderate Degree of Warmth, a gentle mild Breeze of Air may not affect our Faces, which yet would ſtrike us with a Senſe of Chillneſs, if our naked Bodies were expoſed to it.

And a tepid Bath, as that of *Buxton*, may feel neither warm nor cold to our Hands, and yet upon Immerſion may feel cold to our Bodies.

And this Senſation may not only be partial, affecting one Part of the Organ, and not at all affecting the other: but one Part of the Organ may be affected one Way, while another Part is the contrary Way affected by the ſame Cauſe.

Thus the Hand may be in ſuch a Temper, that upon dipping it into the Bath of *Buxton* the Water

ſhall

ſhall feel warm: but upon Immerſion of the whole Body, the Water ſhall feel cold.

And the Air will ſometimes feel warm to our Faces, that would feel cold to our naked Bodies.

We are therefore not to wonder, that either the whole *Retina*, or that any Part of it, after having been intenſely affected with one Senſation for ſome ſpace of Time, ſhould, upon the Ceſſation of the Cauſe that ſo affected it, immediately be affected with a contrary Senſation. It is natural to expect, that thoſe Parts of the *Retina*, which have for ſome Time been impreſſed with a bright Image, as thoſe above mentioned of the ſetting Sun, the Panes of Glaſs, or the white Space between two black Rect-angles, ſhould, upon the Ceſſation of what ſo affected them, be affected with a Senſe of Darkneſs, that is, that a dark Image of the ſame Magnitude ſhould appear in the ſame Place as the bright one had done before. And if a very bright Image had, by the Jolting of a Coach, been transferred to ſeveral Parts of the *Retina* in a ſhort Space of Time, ſeveral dark Images ought afterwards to appear, one for every one of thoſe Parts of the *Retina*.

And thoſe Parts of the *Retina*, that have been for ſome Time taken up with a dark Image, as in the Caſe of the black Rect-angle, the Wood in the Window-frame, or the black End of a Pen, while the neighbouring Parts have been occupied by bright Images, that is, thoſe Parts which, one may ſay, have been in the dark, while the neighbouring Parts have been in the light, will now, as ſoon as that in equality ceaſes, be affected with the contrary Senſation; and this will cauſe the Appearances of the bright Images, ſimilar and equal to the dark ones thoſe Parts were before poſſeſſed with.

Hence it is a neceſſary Conſequence, that after viewing the black Rect-angle, abovementioned, for ſome Time, upon the leaſt unavoidable Nutation of

of the Head, ſome Part of the *Retina*, which had been occupied by the dark and feint lucid Lines, without the Image of that black Rect-angle, would now be impreſſed by the Light of the white Paper; and this ſudden Tranſition from Dark to Light, would cauſe the Light upon that Part of the *Retina*, to appear ſtronger than upon the other Parts, which had all along received the Light of the white Paper; that is, a luminous Border would appear, brighter than the reſt of the Paper.

And when the Eye was a little diverted to one ſide, in order to conſider more attentively this luminous Border, by this Means a Part of the *Retina*, which was before poſſeſſed with Part of the Image of the black Rect-angle itſelf, would now be impreſſed with the Light of the white Paper, and by having undergone a greater Degree of Darkneſs than the former Part, it would be affected with a ſtill ſtronger Senſation of Light; that is, the luminous Border would not only appear broader, but ſtronger than before.

Our learned Author concludes this ESSAY with ſaying, "He ſhould hardly have been thus particular "about the *Phænomenon* he has been laſt ac- "counting for, but that he cannot help ſuſpect- "ing, that even the great Sir ISAAC NEWTON "himſelf was once led into a Miſtake by a like "Appearance. At leaſt, he does not find, he has "any where accounted for the extraordinary Strength "of the Ring of Light, next the central black "Spot, ſpoken of in Obſervation 23. Part I. of "his ſecond Book of Opticks, nor does Dr. *Jurin* "ſee any Way of accounting for it, but from ſome "ſuch Conſideration."

ARTICLE

## ARTICLE XVIII.

*These anonymous* Obſervations *were tranſmitted to me by the General Poſt; and as the ingenious Author has not thought fit to diſcover himſelf by his Quality or Abode, I muſt content myſelf with acquainting him by their Publication that they were received as he intended, and with this Opportunity of acknowledging the Favour of them, as they deſerve.*

### Remarks on MILTON's Paradiſe-loſt.

### BOOK I.

SATAN perſuading Belzebub to continue in Oppoſition to God, ſays,

*l.* 116. — Since by Fate the Strength of Gods
AND this Empyreal Subſtance cannot fail, *&c.*
We may with more ſucceſsful Hope, *&c.*

Here Satan is abſurdly made to contradict himſelf and the preſent Experience of all his Followers, in ſaying that the *Strength of Gods*, (that is, the Strength of the fallen Angels) could not fail, when it had ſo *fatally* failed. The Copulative ſhould be thrown out, and the Lines read thus,

" Since by Fate (the Strength of Gods)
" This Empyreal Subſtance cannot fail.

*i. e.* Since by Fate, which is the Strength of Gods, or God, (he impiouſly ranking himſelf and his

his Crew in equality with God) our Being is immortal. And this is the Senſe the Context requires.

The ſaying God was upheld by Fate was the repeated and conſtant Blaſphemy that *Satan* and his Followers are all along made to vomit againſt Heaven.

*l.* 376. —— Say Muſe their Names then known,
who firſt who laſt
Rouz'd from the Slumber on that fiery Couch:
At their great *Emperor*'s Call.

Dr. *Bentley* ſays,—— "Here, in imitation of *Homer* "and *Virgil*, who give Catalogues of their Captains "and Forces, our Author gives a Liſt of the principal "*Devils*, with their Characters; but it is not the fineſt "Part of his Poem." I think it is, in the Deſign and Drawing, if not in the Colouring; for the *Paradiſe Loſt*, being a Religious Epic, as a late Writer has ſhewn, nothing could be more artful than thus deducing the Original of Superſtition. This gives it a great Advantage over the Catalogues he has imitated, for *Milton*'s becomes thereby a neceſſary Part of the Work, as the Original of Superſtition, an eſſential Part of a Religious Epic, could not have been ſhewn without it. Had *Virgil*'s or *Homer*'s been omitted, their Poems would not have ſuffered materially, becauſe in their Relations of the following Actions we find the Soldiers, which were before catalogued: but by no following Hiſtory of Superſtition that *Milton* could have brought in, could we find out theſe *Devils* Agency, it was therefore neceſſary he ſhould inform us of the Fact.

*l.* 645. ——Our better Part remains
To Work in cloſe Deſign, by *Fraud or Guile*,
What Force effected not.——

Dr.

Dr. *Bentley* ſays there is no Difference between *Fraud* and *Guile*, and therefore alters it to

*Fraud* AND WILE.

But there is a great deal of Difference. They bear indeed this Idea in common of *deceiving covertly*, and therefore the Poet ſays — *to work by cloſe Deſign* — But then they have this Difference: *Guile* is a Deceit, where the Deceived is ſuppoſed to co-operate with the Deceiver, *Fraud* where he is not. This Difference is clearer ſeen in the Verbs to *defraud*, to *beguile*; and this is a Difference much to the Purpoſe of the Story.

*l.* 679. —— " Mammon led them on,
" Mammon, the leaſt erected Spirit that fell
" From Heav'n, for ev'n in Heav'n his Looks
" and Thoughts
" Were always downward bent; admiring
" more
" The Riches of Heav'n's Pavement, trodden
" Gold,
" Than ought divine or holy elſe enjoy'd
" In Viſion beatific: *by him firſt*
" Men alſo, *and by his Suggeſtion* taught,
" Ranſack'd the Center, and with impious
" Hands
" Rifled the bowels of their Mother Earth
" For Treaſures better hid ——

Dr. *Bentley* ſays, " the Poet aſſigns as *two* Cauſes " *him* and *his Suggeſtion*: Is it not one and the " ſame Thing? In ſo beautiful a Poem this ought " not to be ſuffered. It may be thus altered"

" In Viſion beatific, ON HIM LOST.
" Men alſo FIRST by his Suggeſtion taught.

This Obſervation has the Appearance of Accuracy. But *Milton* is exact, and alludes in a beautiful Manner to a ſuperſtitious Opinion, generally believed amongſt the Miners: That there are a ſort of Devils which converſe much in Minerals, where they are frequently ſeen to buſy and employ themſelves in all the Operations of the Workmen; they will dig, cleanſe, melt and ſeparate the Metals. See *G. Agricola de Animantibus Subterraneis.* So that *Milton* poetically ſuppoſes *Mammon* and his Clan to have taught the *Sons of Earth* by Example and practical Inſtruction, as well as Precept and mental Suggeſtion.

*l.* 738. —— "Nor was his Name unheard or
"unador'd
"In ancient *Greece*; and in *Auſonian* Land
"Men call'd him *Mulciber*; and how he
"fell
"From Heav'n they fabled.

Dr. *B.* ſays —— "This is *careleſly* expreſſed. "Why does not he tell his Name in *Greece*, as well "as his *Latin* Name? and *Mulciber* was not ſo "common a Name as *Vulcan.*" —— I think it is very exactly expreſſed. *Milton* is here ſpeaking of a Devil exerciſing the *Founder*'s Art: And ſays he was not unknown in *Greece* and *Italy.* The Poet has his Choice of three Names to tell us what they called him in the claſſic World, *Hephæſtos*, *Vulcan*, and *Mulciber*, the laſt only of which deſigning the Office of a *Founder*, he has very judiciouſly choſen that.

## BOOK II.

*l.* 146. —— "Who would loſe,
"Tho' full of Pain, this intellectual Being,
"Thoſe

" Thoſe Thoughts that wander thro' Eternity,
" To periſh rather, ſwallow'd up and loſt
" In the wide Womb of uncreated Night,
" Devoid of Senſe and MOTION? ——

Dr. *B.* ſays —— " Who (ſays the Poet) would " be annihilated, loſe his intellectual Being and all " his Thoughts? MOTION therefore is an impro- " per Word here, that's no Part of Thought, nor " abſtracted, has any Excellence in it" —— So far is right — He goes on — " I am perſuaded he " gave it, *Devoid of Senſe and ACTION*, depri- " ved of our two Faculties, *to perceive and to act.*" I am perſuaded he gave it with a much leſs Change from the preſent Reading.

Devoid of Senſe and NOTION.

Theſe are properly the two Faculties of the *intellectual Being* —— *Senſation* and *Reflection.*

*l.* 155. —— " Will he, ſo wiſe, let looſe at once
" his Ire,
" Belike through *Impotence*, or unaware,
" To give his Enemies their Wiſh ——

Dr. *B.* ſays, — The Ideas here do not agree, " *Will he ſo* WISE do a Thing he deſigns not " thro' IMPOTENCE. *Impotence* is not the Oppo- " ſite to *Wiſdom* but to *Power.* The Author muſt " have given it *Belike thro' INSCIENCE.*" But *Impotence* is here the Oppoſite to *Wiſdom*, *Milton* here uſing it in the *Latin* Senſe of the Word, for the ungovernable Reſentment of great ones in Power, *immoderata potentia.* So *Tully*'s Tuſc. — *Item inflammant appetitione nimia, quam tum cupiditatem, tum libidinem dicimus, IMPOTENTIAM quandam animi à temperantia et moderatione plurimùm diſſidentem.* That this is the Poet's Senſe of *Impotence* appears from

" Will he ſo wiſe, *let looſe at once his Ire.*

*l.* 1037. —— " Here *Nature* firſt begins
" Her fartheſt Verge; and *Chaos* to
" retire
" As, from *her* outmoſt Works, a bro-
" ken Foe,
" With Tumult leſs and with leſs hor-
" rid Din.

Dr. *B.* ſays —— " If HER Works, then *Nature* " retires, contrary to the Poet's Thought. But *Na-* " *ture* is meant for the new made World, and is of " our ſide againſt *Chaos.* So that the Author muſt " have given it that *Chaos* retired.

" As from HIS outmoſt Works a broken Foe.

Strange! *Chaos* is here repreſented as aſſailing, and *Nature* as defending. Muſt not then, according to all military Conceptions, the *Outworks* be *Nature*'s. The Conſtruction of the Words too is as eaſy as the Thought. Chaos *begins to retire from the outmoſt Works of Nature, as a broken Foe with leſs horrid Din.*

## BOOK III.

*l.* 160. —— " And to Hell
" Draw after him the whole Race of Man-
" kind
" By him corrupted ——

Dr. *B.* ſays, — *This is miſerably flat and creeping with wretched Accent: Raiſe it a little thus*, &c. — But if I have any Conception of the Poet's Art of Harmony, to raiſe it would be to ſpoil it. In this

this Reluctancy of the Numbers to move forward lies a great Beauty, the labouring of the Verſe ſhewing that the Devil would draw very unwilling Followers. And the Image is vaſtly heightened by the Syſtem of *original Sin*, which the Poet goes upon, and which teaches, that notwithſtanding all the Endeavours of *Adam*'s Poſterity to regain God's Favour, they were inevitably doomed to Hell for his Tranſgreſſion.

*l.* 298.—"So Heav'nly Love ſhall undo Helliſh
"Hate,
"*Giving to Death* and dying to redeem."

Dr. *B.* ſays—"Every one that reads with any "Attention, muſt needs ſtumble at this Verſe, "*Giving to Death*, an odd Signification of giving. "Is it the ſame as *yielding?* Allow that—yet "why does he add *and dying?* As if *dying* and "*yielding to Death* were not the ſame again. Per- "haps the Poet might give it thus,

"LIVING to TEACH and dying to redeem."

But let us conſider *Milton*'s Syſtem of Divinity, which taught, not only that Man was redeemed, but likewiſe that a real Price was paid for his Redemption; *dying to redeem* therefore ſignifying only Redemption in a vague uncertain Senſe, but imperfectly repreſents his Syſtem; ſo imperfectly that it may as well be called the *Socinian*; the *Price paid* (which implies a proper Redemption) is wanting. But to pay a Price implying a voluntary Act, the Poet therefore well expreſſes it by *giving to Death*, i. e. giving himſelf to Death, which ſhews *yielding* is not equivalent to *giving*, Freedom and Choice not being implied in the former Word. And yet'tis on this Suppoſition that the Doctor makes

out, that *dying* and *giving to Death are the ſame*; ſo that the Senſe of the Line fully expreſſes *Milton*'s Notion, *Heavenly Love gave a Price for the Redemption of Mankind, and by Virtue of that Price really redeemed them.*

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## ARTICLE XIX.

*The Principles and Connexion of Natural and Revealed Religion diſtinctly conſidered. By* Arthur Aſhley Sykes, *D. D.* London; *Printed for* J. *and* P. Knapton, *at the* Crown *in* Ludgate-ſtreet, 1740. *Octavo. Pages* 507. *beſides the Preface*, &c.

THE Deſign of this Piece, as the Author himſelf tells us, is, ſo to treat of Religion, both Natural and Revealed, as to deduce it from its firſt Principles, and to ſhew that they are both ſtrictly *rational*, and worthy of every ſerious Man's Attention. The Complaint, he obſerves, is very common, that all Religion grows daily into Diſrepute: And it is certainly, as he adds, contemned by many, perverted grievouſly by others, and too much neglected by all. Whether all this Miſchief has not aroſe from Mens not underſtanding the Nature of Religion in general; and from the Religion of *Jeſus Chriſt*'s being ſet in a different Light from what it ought to be ſet in; may deſerve the Conſideration of ſuch as wiſh well to *Virtue*, and to the Cauſe of *Chriſt*. To him it appears, that if the Religion of Nature were ſettled, as it may be, upon a firm Baſis; and the Religion of *Chriſt* were taught as it is in *Jeſus*; and its Evidence were ſet before Men in its due Light; the Objections againſt them would eaſily be anſwered, and it would be

be very hard, if poſſible, to reſiſt their Influence.

Under this Perſuaſion he propoſed to himſelf to eſtabliſh ſuch Principles, from which the ſtrongeſt Objections againſt both natural and revealed Religion (that he had ever ſeen) might be either *obviated*, or fully *anſwered*. He obſerves that thoſe who raiſe the moſt plauſible Objections againſt Chriſtianity, raiſe them chiefly from the *irrational* Grounds upon which it is defended, or the *irrational* Doctrines it is ſaid to teach. His Deſign therefore is ſo to repreſent *Religion*, both natural and revealed, as they are *in themſelves*; and in ſuch a manner as may ſhew what Ground there is for a rational Faith; and by that Means to guard againſt, or to anſwer the Objections, which to ſome appear very formidable.

With this View he has conſidered Man in this Diſcourſe as *obliged* to follow a certain *Rule* or *Law* of Action, from which if he ſwerves, he cannot but be accountable to the great Governor of the Univerſe: He proves, That as it is a Matter of *Duty* to obſerve it, *Religion* comes in in Aid to inforce the Obligation; and *Revelation* ſtill adds more and more *Motives* to encourage and excite Men to what they are *obliged* to do as *rational Agents*.

This being the general Plan, it became neceſſary to inquire, What the Rule or *Law of Action* to all Mankind is? Whether they can find it out of *themſelves?* Or, Whether they were obliged to go to *Revelation* for it? And how far in *Fact* Men did proceed in theſe Reſearches, before the Days of *Chriſt?*

In treating of *Revelation*, he thought it neceſſary, not only to mention the Advantages of it in *general*, but to deſcend to *Particulars*, and to name the Doctrines that were revealed, and to point out the particular Deſign and Benefit of them.

As every Man has a Right to demand *extraordi-*

*nary Evidence* for any *extraordinary Fact*, and particularly for ſuch an *extraordinary* Fact as *Revelation* is, ſuch he has produced: Such as will ſatisfy the Reader that it cannot proceed from Impoſture, but that it ſtands upon a Baſis as immoveable as Reaſon itſelf.

This Treatiſe is divided into fifteen Chapters, in the Front of which there ſtands an Introduction of four Pages, wherein our Author expoſes the Folly and Wickedneſs of treating all Religion as a Matter of *Policy*, to influence the common People, and to keep them in Order; and conſtantly ſpeaking of all Revelation as *Impoſture* or *Enthuſiaſm*, as is the ordinary Practice of ſome Men. He ſays, "Were "any to declaim againſt the Wildneſs and Ex- "travagance of ſome Religioniſts; or were they "to be ſevere on the Unreaſonableneſs, or Unintel- "ligibleneſs, of Notions and Doctrines, inſiſted "on by ſome as of great Importance, and even as "neceſſary to Salvation, they might have Oppor- "tunities of doing it with Juſtice and Truth. But "to treat all Religion as a mere *political* Con- "trivance, adapted only to regulate and manage "*Society*; and to reject Revelation, becauſe ſome "groſs Abuſes or Miſinterpretations have been in- "troduced by Men in Power and Authority, and "have been ſupported by Zealots in all Commu- "nions——This argues a great Ignorance of the "firſt Principles of Reaſon, or a weak Judgment, "or a great Neglect of Conſideration. Let a Man "refute any Notion that appears to him to be falſe; "let him declare againſt all Abſurdities, let him "reject all Errors: But as it would be very unrea- "ſonable to renounce Truth itſelf, becauſe it has "had ſome Falſhood intermingled with it; as it "would be ridiculous to reject all Geometry, be- "cauſe there are thoſe who boaſt of their having "demonſtrated what cannot poſſibly be done; ſo

"muſt

" muſt it be abſurd to reject all Religion, becauſe " it has been groſsly perverted by weak or wicked " or ignorant Men. It is true, that ſome have " interwove a worldly Power and Intereſt into it: " They have erected a Kingdom of *this* World " under the Cover of ſetting up one that is not " of this World. Let this Art be detected; let the " Iniquity of ſuch a Proceeding be diſplayed; and " let all temporal Views, under the Guiſe of Re- " ligion, be treated as Hypocriſy and Diſſimulation " ought to be: But let not Truth be ſacrificed, nor " Religion (which is capable of ſtrict Evidence) " be given up as a Victim to the Abſurdities of " any Sect or Party of Men whatever."

In the firſt Chapter our Author inquires, *Whether there be any certain* Rule of Action *to Man, and what that is?* That there is a certain Rule of Action to Man, appears, he ſays, from hence, " That all Nations and all Languages have Words " by which they expreſs *Good* and *Evil*, Right and " Wrong, virtuous and vitious Actions. They muſt " therefore all have ſome Teſt or other, whereby " they diſtinguiſh Actions, and range them, as under " their proper Claſſes: For they never *indifferently* " uſe the Terms *Good* and *Bad*, nor do they ever " call the ſame Action in the ſame Circumſtances " *Right* and *Wrong*."

As to the *Nature* of this *Rule of Action*, our Author, upon a thorough Examination, determines it to be *the Truth of Things*. He conſiders what may be objected to this, and ſhews it to be of no Force. He evinces the Univerſality of this *Rule*, its Applicableneſs to all Caſes. He ſays, " Truth " is the Rule of Action to all intelligent Beings, " not only in *moral* Caſes, but univerſally in all: " Nor is it neceſſary to look out for different Rules " for different Sorts of Action, one for moral, a- " nother for mathematical, a third for phyſical

" ones,

" ones, ſince this one is the proper, juſt, and ade-
" quate Meaſure of all. For what is a virtuous
" Action, but the obſerving and following the
" *true* Relations of Perſons and Things in the given
" Caſe? Juſt as the making a good Clock or
" Watch is obſerving the true Properties of the
" Materials made uſe of, and working them up
" exactly, or truly. And there is this Advantage
" in conſidering and meaſuring Actions by this
" Rule, that no Caſe can be put, either in Rela-
" tion to the Actions of God, or Man, or any
" Beings ſuperior to Man, but they may be meaſured
" by it."

He afterwards takes notice of other Rules that have been propoſed. But of theſe he pronounces, " that they are either deficient when they come to " be applied to the Actions of God; or elſe they " are the ſame with that which is here laid down, " though expreſſed in different Words; or they are " no Rules by which in our preſent Circumſtances " we can try our Actions."

One of the Rules which Dr. *Sykes* thus diſcards is the *Will of God*, which ſome make the Foundation of all Morality, telling us that his Command alone makes it rational, fitting, or ſafe to practice Virtue. It is *he* that *binds* us; it is *he* that *obliges* us to it, by connecting our true and certain Happineſs with it.

This Way of talking the Doctor is far from approving. The Will of God when known, he allows, is certainly a very good Rule of Action: " But to ſay " that his Command alone makes it rational to prac-
" tiſe Virtue, is to leave Men at large, whether they
" will practiſe it or not, where his Command is not
" known. And which Way is the Will or Command
" of God to be known, where there is no Revelation
" of it? Is it to be gathered from the Compariſon
" of Ideas, and from the Relations of Things?

" If

" If ſo, what is the *Will of God* but other Words " for *Truth?* Nay, ſuppoſe a poſitive Revelation " given; is not this to be interpreted by the Na- " ture of Things?——It certainly muſt, unleſs " Reaſon be diſcarded: And if that be once gone, " we ſhall have no Teſt to diſtinguiſh the Will of " God from the Illuſions of the Devil, or the Im- " poſtures of Men.

" But indeed the Will of God does not make " the Relations of Things, but only *makes them* " *known.* God does not *make* Truth, *but conforms* " *his Will*, and requires that we ſhould conform " ours to Truth.——God might indeed have made " the World in a very different Manner; and he " might, had he pleaſed, have given us better Fa- " culties, or he might have given us different ones " from what he has. And in this Senſe it may " be ſaid to be owing to the *Will* of God, that the " Relations of *exiſtent* Things are what they are: " But when this is ſaid, no more is meant than " that Things exiſt *in Fact* as they do. But whe- " ther the preſent World had been created or not, " it did not depend on the Will of God, that the " Ratio, or Relation of the three Angles of a " rectilinear Triangle to two right ones ſhould be " that of Equality.——

" The *Will* of God itſelf is governed and di- " rected by *Truth*, *i. e.* by the true Habitudes and " Relations of Things; and this is a ſufficient " Reaſon why it may be ſecurely relied on. But " take away this, and what Evidence is there that " that which is true and right to-day, may not be " falſe and wrong to-morrow?——What is called " the *Will* in any Agent, is nothing but the " Power he has to begin or forbear Action; to " begin to conſider or to forbear Conſideration: " But it has nothing to do with Truth or Falſhood " (which belongs to another Power, *viz.* Intellect)

" except

" except it be to act according to the Perception of " the Nature of Things, or contrary to them. " The *Will* of God therefore cannot be the *Rule* " of his Actions, but his Underſtanding muſt: " Nor can it be the Rule of *our* Actions, but as it " is governed by *Truth*, however made known unto " us; and conſequently Truth is in reality our only " Rule."

Having conſidered *Truth* thus far as the *Rule* of Action, our Author proceeds to ſhew it to us in a ſomewhat different Light, as a *Law*. Every *Law*, as he ſays, is a *Rule* of Action; but then it implies more than a bare Direction; *viz.* an *obligatory* Quality; a *Rule* has only a *directive* Force, whereas a *Law* has a *directive* and an *obligatory* Power too. The *obligatory* Quality of a Law, he obſerves, is uſually taken to be the *Pleaſure* or *Pain* annexed to Obedience or Diſobedience: But this is not properly the *Obligation*, but a Motive to comply with *Obligation*; which by a common Metonymy has at length acquired the Name, and is uſually treated as *Obligation* itſelf.

He therefore inquires, what *Obligation* is, and whether Truth *obliges* Men or not? His Concluſion is, that " *Natural Obligation*, or, as ſome call it, " *Obligation of Equity*, is nothing but the Perception of Truth, and the Affection of the Mind " upon ſuch Perception. Truth has the directive " Force according to which the Action is to be " done: And it moreover puts the Mind into ſuch " a State, that if Action is not done according to its " Direction, the Man is conſcious of ill Deſert, " or of being worthy of ſuffering for it. This " renders him *obliged* to act otherwiſe; not *compelled*, not *neceſſitated*, not deprived of his *natural Liberty*, not ſo much as leſſened in his " Privileges, but tied to act as being what he is, " an underſtanding as well as free Being."

There

There are ſome Inferences that ſeem to be connected with this Syſtem, which at firſt View have but a diſagreeable Appearance. " Does it not follow " from hence, that all Deviation from Truth in " all Caſes, in not moral as well as moral Actions, " is *ſinful?* Will not Sin, and the Conſequences " of Sin abound? Will not every Miſtake, Inaccuracy in Work of all Sorts, be looked upon as " ſo many Violations of a Law, and conſequently " become penal in the Sight of God, who requires " the Obſervation of this Law from all intelligent " Creatures?"

A Part of what our Author has replied to all this is, " That ſuch is the real Conſtitution of " Things, that no Man can ever deviate from " Truth in any Caſe, but ſome ill Conſequence " ariſes; ſometimes indeed ſo ſmall as not to be " regarded, but oftentimes ſo fatal as to prove ruinous to the Agent. Whoever ſhall call this a " *Puniſhment*, will ſpeak inaccurately, becauſe it is " only a natural Conſequence of Things; and " Puniſhment is always ſomething inflicted more " than what ariſes immediately from the Action " itſelf. However, it is certainly true, that whoever makes any Piece of Work truly, anſwers " all his Deſigns much better, than if he does it in " an inaccurate Manner. So that the great Law of " Truth is not without its Sanction even in Caſes not " of a moral Nature. The Matter is much the " ſame in Caſes of *moral* Action; where Truth " carries with it an inward Pleaſure, a Conſciouſneſs of the divine Favour, and the Approbation " of all Mankind; whereas Vice is attended with " juſt the contrary, beſide its rendering the Actor " liable to what Puniſhment the Governor of the " Univerſe may think fit to inflict, becauſe he had " it in his Power to act otherwiſe, and would not " exert that Power as he could."

The

The ſecond Chapter of this Diſcourſe includes a Detail of ſeveral Conſequences, which naturally ariſe from Truth's being the Rule and Law of Action. I will ſet down the Topicks on which our Author here expatiates.

*Firſt*, It is the Duty of all Men to direct and govern their natural Abilities by the certain Rule of Truth, or agreeably to the real (not imaginary) Circumſtances of Things. --- Not to *one* or *more* particular Circumſtances taken independent of others, but to the *whole*, or to what makes up the *Truth of the Caſe* in which the Man ſtands. *Particular* Circumſtances, how true ſoever, do not make up THE Truth, but all of them put together. ———

*Secondly*, The Law of Nature muſt be of conſtant and perpetual Obligation. — It is founded in the Nature of Things, or in the Relations which intelligent Beings ſtand in to one another; and therefore muſt be obligatory as long as ſuch Beings exiſt. — When this Law is practiſed from a Senſe of the Being of God, it becomes then the *Religion* of Nature, and comprehends the Duty of Man to God, to his Neighbour, and to Himſelf.

*Thirdly*, The Circumſtances of Things being various, and their Relations to one another in many Caſes unknown to us, it follows, that we ought to lay up in our Minds as many *particular true Propoſitions* as we can, that theſe being duly conſidered may help to direct us to right Action. —— If we frame to ourſelves a Rule of Action from a ſingle Propoſition, where more than one are required to ſhew the full State of the Caſe; or if we do it from a very narrow View of Things, we may be guilty of great Miſtakes and Errors. " 'Tis certain in " Fact that the Good and Evil of this Life is pro- " miſcuouſly diſpenſed; and good Men ſuffer evil " things, and evil Men receive good things. Take " this Fact by itſelf, and turn it over ever ſo often,

" and

" and it is impoſſible to know whether the Con-
" cluſion be, either that there is no juſt Governor
" of the Univerſe, or, that there is to be a future
" State of Recompence. But ſuppoſe a Man con-
" vinced of the Truth of this Propoſition, that
" God exiſts, a Good and Juſt and Wiſe Being;
" and that then he comes to conſider the unequal
" Diſpenſation of Things; the Conſequence will
" then be certain, that the preſent cannot be the
" whole of our Exiſtence, but there muſt be a
" State when all theſe Inequalities will be made
" up." ——

*Fourthly*, Whoever they be, that under any Pretence whatever attempt to leſſen the Force or Senſe of the Obligations of the Principles of Honeſty; or that would weaken the Obligation of Morality, by making it bend to Politicks; or would influence Men to act contrary to Truth and Right; or that imagine nothing to be true but what Superiors command; or that do not pay a ſacred Regard to Truth; or think that Men ought to pay a greater Regard to any thing than Truth; they are the greateſt Enemies to Virtue and Honour that can be, and ought to be deteſted by every ſerious Perſon.

*Fifthly*, Truth being the Rule of Action, the Wiſdom of God has ſo ordered Matters, that we never deviate from Truth, the Truth of the Caſe, but we find an Inconvenience proportionable to the Deviation from it. This has led ſome to imagine that all *Obligation* ariſes ſolely from the Good or Evil which is annexed to, or conſequent upon the Performance, or Non-performance of an Action. --- But Happineſs or Miſery do not *make* the Rule of Action, but *ſuppoſe* it: They are the *Motives* or *Reaſons* why we ſhould carefully attend to Truth: And becauſe we might be negligent, or might even wilfully tranſgreſs our Duties, therefore God has annexed

annexed theſe as Sanctions to what is the Rule of Action.

*Sixthly*, However difficult it may be in certain Caſes to diſcover *Truth*, yet it muſt be obſerved that *Moral Truths* are generally eaſily intelligible. — Indeed the Minds of Men are ſo framed, that Truth is as obvious to them, when the Terms made uſe of to expreſs it are clear, as Colours are to their Eyes, or Sounds to their Ears. But as Art may compound a Colour that cannot eaſily be diſtinguiſhed by the Eye from another that very nearly approaches it, ſo a Caſe may be ſo perplexed by interweaving of many Circumſtances, that no one is able to underſtand what is the Truth. Whenever this happens, a Man muſt be liable to blame for acting at all; becauſe the Truth of the Caſe is ſo involved, that he ought not to act, as having no Rule to direct him.

*Seventhly*, The great Objection againſt making Truth the Rule or Law of Action, may now receive an eaſy Solution. 'Tis urged, that if Truth be the Rule of Action, and every Action be good that agrees to *Truth*, then every Action will be good: "For there being as many Truths concern-"ing Vice as Virtue, this will make the Obliga-"tion to purſue the one, as great as the Obligation "to purſue the other, e. g. *Robbery diſturbs So-"ciety, diſcourages Induſtry.* Theſe are Truths "concerning Vice. Ought we to act according "to them?"

Our Author's Anſwer is, *Firſt*, ſuppoſe that oppoſite Truths may be formed about any thing, i. e. *Injuſtice deſtroys Society — Juſtice preſerves Society.* This is nothing but the ſame Truth maintained under different Expreſſions; *e. g.* Injuſtice is the ſame with, *not Juſtice* or *Juſtice*; and to *deſtroy* is equal to *not preſerve.* Now two Negatives being equal to an Affirmative, or deſtroying each other, 'tis plain

plain that —— *Injuſtice deſtroys*, is equal to —— *Juſtice preſerves* Society: So that oppoſite Truths may be nothing elſe in reaility but the ſame Truth differently expreſs'd.

Should it be inſiſted on, that oppoſite Truths are quite different in themſelves, and not only in Expreſſion; that *Injuſtice* is not the ſame with *not Juſtice*, but ſomething poſitive in itſelf —— Then, *Secondly*, it may be ſaid, That the Truth of a ſingle Propoſition is not, or may not be, THE Truth, the *whole* Truth, the Truth of the Caſe, but only a *Part* of the Truth. —— Thus in the preſent Caſe, it is a true Propoſition that *Injuſtice is deſtructive of Society*; but then to act upon ſuch a Propoſition does not make the Action *good*, becauſe many other Truths muſt be violated by him that will deſtroy Society, and conſequently he does not act upon *the Truth of the Caſe*.

Here therefore is a ſtrange Paralogiſm offered by means of the Word *Truth*. This Term ſignifies a *True* Propoſition; and it likewiſe ſignifies (as it always does in the preſent Subject) *The Truth of the Caſe*; all the Circumſtances of the Thing. A *true Propoſition* ſometimes ſignifies the *whole* Truth, or *the Truth of the Caſe*; and then to act upon ſuch a true Propoſition, is following THE Truth. But when a true Propoſition does not contain or expreſs the *whole Truth* of a Caſe, he that acts upon ſuch a Truth may be guilty of enormous Wickedneſs: Whereas he that acts upon THE Truth of the Caſe never can be guilty of any Evil.

Dr. *Sykes*, in his more extenſive reading or Converſation, may have met with theſe Pleas: I never did. They ſeem, I think, below the loweſt Underſtandings, and quite unworthy of the Pains ſo learned a Writer has taken to obviate them. There needed no Labour to prove, that there can be no obligatory Truth concerning Vice, but what is identical (I think I may ſay) with this Propoſition, That it is hurtful,

and ought to be avoided: And if ſo, the Dr. might have ſpared all his curious Reaſoning upon this Head; Part of which however I have above inſerted.

*Eighthly*, The different manners of expreſſing themſelves have led ſome to imagine a Difference between Writers who have treated on the Foundations of Morality, who yet really mean one and the ſame Thing. Some call it *Truth*; others, the Nature of things; others uſe the Terms *Fitneſs*, *Agreement*, or *Relations* of things to one another. Theſe Terms, when explained, all ſtand for very nearly the ſame Ideas; and if People were not diſputatious, any one of them might be uſed to expreſs the Rule of Action.

*Ninthly*, Moral Rectitude, or Moral Pravity do not ariſe from any natural Good or Evil annexed to the Rule, but from the Agreement to, or Diſagreement from, the Rule itſelf to which the Action is refer'd; and this the Term, *Rectitude*, implies. ———

It is true in fact, that God has annexed *Pleaſure* or *Pain* to Moral Actions, by poſitive Law, as he has natural Conveniences or Inconveniences to *natural* Actions. If this be what makes *Obligation*, it would be abſurd to ſay that God is under *Obligation*; ſince he cannot have any Happineſs added to what he enjoys, or any Miſery inflicted on him. But let it be conſidered, that *God has a* Law, *or* Rule *of Action, as certain as Man, or any other intelligent Being has*; that he conforms his Actions to that Rule or Law conſtantly; that his being free does not give any Power or Liberty to recede from that Rule or Law; that his Perception of Truth or the true Relation of things to one another, does in ſtrictneſs *oblige* him to act agreeably to them; that he would not be *good* or *juſt* if he did otherwiſe ——— Let this, our Author ſays, be conſidered, and it will

will again be evident, that Happineſs or Miſery is not the Rule or Law of his Actions, but *Truth*; and that which *obliges* him, *obliges* us and all intelligent Beings. And this ſhews us in what the *Rectitude* of Action conſiſts.

This, our Author ſays, cannot be expreſſed in too many different Manners, becauſe it is a Matter of the greateſt Importance. Accordingly his Readers will find ſeveral Obſervations under this Head, beſide thoſe I have here cited, calculated for giving him the moſt clear and preciſe Idea of it.

*Tenthly*, As Truth is the Rule of Action, all known Violation of it in *phyſical* Caſes is Folly, becauſe we cannot alter the Relations of Things: But in *Morals* it muſt be Sin; and muſt expoſe the Man that does it, to ſuch Puniſhment as his Superior and Judge ſhall think fit to impoſe.——

*Laſtly*, Hence the common Caſes which are put, in relation to the Deception of *Children*, *Idiots*, *Madmen*, *Ruffians*, may receive an eaſy Solution. For let the true Circumſtances in any of theſe Caſes be ſtated, and the Action, Dr. *Sykes* ſays, ought to be according to them. It is a Parent's Duty, *e. g.* to preſerve his Child's Life, which cannot be done without the giving him a certain Doſe of *Hierapicra*, which he refuſes to take becauſe of its bitter Quality. To deceive him in the Potion, the Cup is ſmeared with Honey, and by this Art the Child is induced to drink what is ſo neceſſary for his Preſervation. 'Tis right, the Doctor ſays, to do it; and the Parent would not follow *the Truth*, the Truth of the Caſe of the Child, if he did it not. So to take away privately a Sword from a Madman, or the deceiving him by an Untruth of Falſhood, to prevent his hurting himſelf or others, is acting according to the Truth of the Caſe: And ſhould any one make it appear that the Truth of the Caſe is not on this Side of the Queſ-

tion, he would prove that a Man is obliged *not* to act in this Manner by the *Child* or *Madman*, but not that the Rule of Action is not THE Truth.

We come now to the third Chapter, wherein the Doctor has, in a very brief and perſpicuous Manner, diſcuſſed a Queſtion, concerning LIBERTY, that is of the utmoſt Conſequence in an Inquiry whether Mankind is under any *Obligation* to be *religious*. And here firſt he ſhews, That if Men are impell'd by *Fate* or Neceſſity, they can't be *accountable* for what they do; nor can there be any Rule of *Action* to them. In the next Place, he ſtates the Arguments which are uſually urged againſt *Freedom* or *Liberty*. Laſtly, To clear up a Point, which has been very much embarraſſed by the Subtlety of Diſputants, and to evince the proper Agency of the human Species, he makes ſeveral Obſervations, the Sum of which here follows.

*Firſt*, There is no Abſurdity or Impoſſibility in the Notion of *Liberty* or *free Agency*, or, that a Being may have a Power of beginning or ſtopping Action; of moving, or not moving, according to the Determination of his own Mind.

*Secondly*, It is capable of ſtrict Evidence, that *God* has in Fact a Power of *Action*. "For were "God a *neceſſary* Being, it is impoſſible that he "ſhould ever have made a *Variety* of Beings, at "the ſame Time: And much leſs could he have "made any *finite* Beings, as all the Works of his "Hands (that we have any Knowledge of) mani-"feſtly are. Suppoſing him to be a *neceſſary* Be-"ing, then whatever it was that obliged him to "exert his Power, muſt oblige him to exert all that "he had. Now his Power being infinite, the Effects "of it muſt be infinite; and conſequently every Crea-"ture the utmoſt Effect of infinite *Power*. For "where any Being is urged by *Neceſſity*, there is no "increaſing or diminiſhing its Effect, ſince the *whole*

"Power

" Power that it has muſt be exerted, *e. g.* Where " a Stone falls, its whole Power is exerted, nor can " it alter its Force nor vary its Direction any Way; " but which Way ſoever it is impelled, that Way it " muſt go, and with its *whole* Force.——Juſt " in the ſame manner were God as *neceſſary* a Be- " ing as a Stone, or Fire, he muſt likewiſe exert " his *whole* Power in doing whatever he did.—— " In like manner it follows, that he could not have " made *two* of any Sort of Beings to begin to ex- " iſt at the ſame time;—or indeed any Variety " of Things: For the whole Power of God, his " infinite Power, being exerted upon each Parti- " cular, and it being impoſſible to *alter* or *vary* it, " ——He could no more produce a *Variety* of " Beings at the *ſame Time*, than a Stone can move " in different Lines at the ſame Time.

" Since then there are not only finite Beings, " but a great Variety of them; and they did be- " gin to exiſt at the ſame time; it follows, that " God is a *free* Being, or has a Power of acting, " or not, according to the Determination of his " own Mind."

*Thirdly*, As *Liberty* is a *poſſible* Power, and *God* in fact has it, ſo has he veſted Man with it. " We " are ſo made that we can gain *Habits* or loſe " them; we can alter by Cuſtom our very Frames " and Conſtitutions.——Now *Habits* cannot be " acquired or loſt in Things that are *neceſſarily* " moved. Throw a Stone up ever ſo often,— " it will aſcend exactly with the ſame Velocity " that is impreſs'd; and will deſcend with exactly " the ſame Velocity that it did the very firſt time. " Light Bodies cannot be made to alter their ſpe- " cific Qualities, nor can you by any Repetition " of Trials or Acts ſuperinduce a contrary Ha- " bit; or make them deſcend in the ſame Medium " in which they were wont to aſcend. But it is

" not ſo with Men: They can acquire Habits, can " improve, leſſen, or totally deſtroy them; con- " ſequently they have Powers of their *own* which " are alterable by Cuſtom, which no *neceſſary* " Beings have, or can have.—For all ſuch Things " as are under the Direction of *Neceſſity* can in " no Caſe, in no Circumſtances whatever, change, " or alter, their Directions, but muſt move juſt as " they are impelled."——

The End of Puniſhment, and the Good obtained by it, is another Argument, our Author ſays, to prove that Man is deemed by all to be *free*. " No one ever *puniſhes* a Stone for the Miſchief it " does, or imagines it reaſonable to beat, or whip, " or break it to Pieces, for falling on a Man, and " daſhing out his Brains: No nor do we puniſh a " Man that by his Fall ſhould accidentally kill " another. The Difference between *Action* or " *Paſſion* is ſo univerſally kept up by Mankind, " that proper *Puniſhment* is never inflicted, where " it appears that there was no proper *Action*. And " indeed all Languages have been formed upon " this Principle, that Men are properly Agents."—

If Men therefore have a Power of Action, and have a certain Rule which it is their Duty and their Happineſs to follow, we muſt next conſider, whether there be ſuch a Being as we term *God*, in order to have the exact Principles upon which Religion is and muſt be built.

The Determination of this great Point takes up the fourth Chapter. In the Beginning of it Dr. *Sykes* lays down a Series of Propoſitions which evince the neceſſary Exiſtence of ſome firſt Cauſe, from which all dependent Beings muſt derive their Original, and which we call God; after which he ſhews that we may be likewiſe certain of many of his Attributes.

But as Men have ſtrangely annexed different Ideas

to the Word GOD, ſo he employs the greateſt Part of this Chapter in refuting ſome falſe Notions which have lately been revived concerning him. Thoſe which he has principally in View, were ſet forth, about the Year 1720, in a ridiculous *Latin* Piece, entitled *Pantheiſticon*, † by that deſpicable Knight-Errant in the Cauſe of Infidelity, *John Toland*. The *Pantheiſtic* Scheme is that which *Vanini* and *Spinoſa* profeſſed. And as this ſeems to be the faſhionable Syſtem, eſpouſed by ſuch as are atheiſtically diſpoſed, and yet would ſcreen themſelves under the Cover of a Term which implies the reverſe of Infidelity, our Author here conſiders the Principles on which it is built.

What he has ſaid to this Purpoſe is of ſo uſeful a Nature, that it deſerves a very particular Attention.

In the firſt Place the Doctor ſets down the Paſſages of the *Pantheiſticon*, both in the original *Latin* and in *Engliſh*, which contain thoſe falſe Conceptions of the Deity, which he has undertaken to confute, and then very fully, and I think convincingly, diſplays the Weakneſs and Abſurdity of them.

" They are generally called PANTHEISTS, ſays " *Toland*, on account of a peculiar Opinion of " theirs concerning God and the Univerſe, which " is diametrically oppoſite to the *Epicureans*; and

† The whole Title of the Book is, PANTHEISTICON, *ſive Formula celebrandæ ſodalitatis Socraticæ, in tres particulas diviſæ; quæ* Pantheiſtarum, *ſive ſodalium, continent* I. *Mores et Axiomata:* II. *Numen et Philoſophiam: Libertatem et non fallentem Legem; neque fallandam. Præmittitur, De antiquis et noviis eruditorum ſodalitatibus, ut et de Univerſo infinito et eterno, Diatriba. Subjicitur, De duplici* Pantheiſtarum *Philoſophia ſequenda, ac de Viri optimi et ornatiſſimi Idea, Diſſertatiuncula.* This goodly Piece contains a Sort of Liturgy, or Form of worſhipping the Pantheiſtic Deity: A few Lines of which are cited by our Author; as the Reader will ſee preſently.

" to thoſe that imagine the World was framed from " a *Chaos*; and to the *Viſion-mongers*: Since they " admit no original or primæval Confuſion, no " Fortune, or Accident to be the Maker of the " World; but of the Cauſe and Origin of Things " they ſay with old LINUS, OF THE UNIVERSE " ARE ALL THINGS, AND OF ALL THINGS THE " UNIVERSE. This Line requires a larger Ex- " plication, which take in the following Words:

" The Univerſe (of which this World that we " ſee is but a ſmall Part) is infinite, as well in " Extent as Efficacy; but in reſpect of the " Continuity of the whole, and Contiguity of the " Parts, it is one: Unmoveable in reſpect of the " whole, ſince there is neither Place nor Space be- " yond it; but moveable as to all its Parts, through " infinite particular Spaces: Incorruptible and " neceſſary both Ways, *viz.* in Exiſtence and Du- " ration: Intelligent alſo in an eminent Manner, " not to be called intelligent but by a light Simili- " tude to our Faculty of Underſtanding: Its inte- " grant Parts are always the ſame, as its conſtituent " Parts are always in Motion."

In this Account of the *Univerſe*, " in perpetual " Change, and in which nothing periſhes," where- in " the Death of one Thing is the Birth of ano- " ther," and from whence there is " a beautiful " Variety and Viciſſitude, and in which all Things " neceſſarily operate for the Preſervation of the " whole, and are perpetually revolving as it were " in a Circle," the *Pantheiſts* pretend to explain how " all Things are made of one, and all Things " are reſolved again into the ſame." Now " this " Force and Energy of the whole, the creating and " governing Power of all Things always tending " to the beſt End, is *God*; whom you may call " the *Mind* if you pleaſe and *Soul* of the Univerſe." Hence the *Pantheiſts* have their Denomination;

but

but then they argue, that "this Force is not to be "ſeparated from the Univerſe itſelf, otherwiſe "than by the mere Imagination of the Mind."

In another Part of the ſame Book, the Deity of the *Pantheiſts* is thus deſcribed:

Their Chairman is ſuppoſed to ſay,

"In the World all Things are one, and one is "all in all.

*Anſwer.* "Which all in all is GOD, eternal and "immenſe, neither begotten, nor will ever ceaſe.

*Chairman.* "In him we live, and move, and "have our Being.

*Anſwer.* "From him every Thing had its Be-"ginning, and will return to him again; he being "the Beginning and End of all Things.

*Chairman.* "Let us ſing an Hymn concern-"ing the Nature of the Univerſe.

*All.* "Whatever THIS is, it animates, forms, "nouriſhes, increaſes, makes all Things: It bu-"ries, and retakes into itſelf all Things: The ſame "is the *Father* of all Things; and into the ſame all "Things which ariſe, anew return, and die in it." †

This, ſays Dr. *Sykes*, is the Notion of the Deity which the *Pantheiſts* admit. A Deity! eternal, immenſe, uncauſed, from whom all Things derive their Being, and who can never ceaſe: But then it is a Deity, that is *no Agent*; that cannot have any *Ends* or *Deſigns*; that cannot have *Benignity* or *Benevolence*; that has no *Goodneſs*, as *Goodneſs* is a moral Diſpoſition; that cannot *chooſe*, but muſt ſubmit to the infinite Varieties and Motions which cannot but happen. So that, in Reality, this is in *Words* only to ſay there is a *Deity*, but in fact it is deſtroying his Exiſtence. Thoſe who really mean ſuch a Being as GOD, cannot ſay, that the *Univerſe*, or the *Power* of the Univerſe is *God*, any more than they can ſay either that the Ship is

† This is Part of the *Pantheiſtic* Liturgy mentioned at the Bottom of Page 297.

the

the Pilot; or that the Power and Energy of the Ship is the Pilot. —— Is it not at firſt Sight abſurd to ſay that the *Ship* is the *Pilot?* Is he not diſtinct from it, notwithſtanding he ſteers it? So is the great, the wiſe, the good GOD, not *the Univerſe*, but the *Governour* of the Univerſe. *

There can be no Deity where there is no proper ſpiritual *Dominion* or *Rule*. Now one Part of the Univerſe, as the Sun, or Moon, or Stars, can have no *Dominion* or *Government* at all over any other Part, more than that other Part has over them: Nor if you join the whole Univerſe together, has that any Dominion over its ſeveral Parts. The Univerſe therefore cannot be God; but that Being that governs the Univerſe alone can be entitled to that Appellation. Our Author does not here ſpeak of *Influences*, ſuch as that of Light or Gravitation in the Sun or Planets towards each other; but of ſuch *Rule* and *Government* in Superiors over others, as renders the Inferiors liable to proper Account for voluntary Diſobedience to the Law of their Actions.——

Again: Suppoſing the Univerſe to be God, then whatever is or can be affirmed of any *Part* of the Univerſe, may be affirmed of *Part* of *God:* For the Univerſe has *Parts*, "and as to all its Parts "it is moveable and contiguous;" and the *Parts* joined together muſt make up *the whole*. Now if *God*, as the *Univerſe* does, conſiſts of *Parts*, he muſt conſiſt of ſome Parts *neceſſarily exiſtent* and *unchangeable*, ſuch as Space; and of other Parts *not neceſſarily exiſtent*, but perpetually changing their Form, and periſhing in order to produce others. Now Parts perpetually changing and

* Our Author quotes *Ariſtotle* as having the ſame noble Idea of God, and expreſſing himſelf no leſs properly and ſublimely of the Deity, under this Character of the Rector of the Univerſe, than might be expected from any of the inſpired Writers.

periſhing

periſhing are not *neceſſarily exiſtent*, but may be conceived to be entirely abſent, or not to have been, as well as ſuch as are produced from the periſhing Bodies may be conceived never to be, ſince they receive a Beginning. The Idea therefore of God, upon this Suppoſition, is the Idea of a Being compounded of ſome Parts unchangeable, and others perpetually changing: Immoveable, and yet every Part of him which makes up the whole, is moveable: Every *Part* of him, except what conſtitutes Space, may be conceived *not neceſſary*, and yet the whole is *neceſſary*. Can any Idea, as our Author juſtly demands, be more ſelf-contradictory than this?

"The Univerſe," ſays Mr. *Toland*, "(of "which this World that we ſee is but a ſmall Part) "is infinite, as well in *Extent*, as *Efficacy*; in "*Continuity* of the *whole*, and the *Contiguity* of its "*Parts*, 'tis *one*."

He means, that the Univerſe is made up "of "*infinite Worlds*," and that all theſe make *one whole*. Here, ſays our Author, he takes for granted that there are actually "infinite Worlds," the *aliquot* Parts or *Conſtituents* of the Univerſe, which is infinite in Extent and Power. But then this itſelf is abſurd; ſince no *Number* of *finite* Parts, how great ſoever, can ever conſtitute *Infinity*. Every Number is finite; and every Addition is the Addition of ſomething finite: And the Addition of Finites to Finites can never make any Thing infinite. The Univerſe then conſiſting of ever ſo many Worlds cannot be *infinite*: And what is *finite* cannot be *infinite* in *Power* or *Efficacy*.

And ſo in his *ſecond* Property of the Univerſe: "It is immoveable in the whole, ſince *without* it "there is neither Place nor Space; but it is move-"able as to all its Parts, thro' infinite little Spaces." The Philoſophy of the *Pantheiſts* is deſigned to account

account for the Univerſe, or infinite Worlds, without any Cauſe diſtinct from itſelf. Aſk, Whence proceeded all thoſe infinite Worlds which make up the Univerſe? The Anſwer is—They all proceeded from *the whole*. What is this *whole*, or whence did it proceed? Why, that proceeded from *all the Parts*. The whole indeed conſiſts, or is made up of all its conſtituent Parts; but the great Inquiry is concerning the original *Cauſe* of this *whole*, and of all its *Parts* too; of which nothing is yet ſaid.

The next Step is exactly in the ſame abſurd Manner—This whole is "*moveable* as to all its "Parts." How? through infinite "numberleſs "little Spaces or Intervals." Now, *Firſt*, What is the *Cauſe* of this *Motion?* Matter at Reſt will always continue in Reſt: How then comes the Univerſe to be *moveable*, or actually in Motion in *all its Parts?* There muſt be ſome *Cauſe* of *Motion*, ſome *original Mover*, or elſe the *Parts* of the Univerſe would be as immoveable as the Univerſe itſelf. *Secondly*, All the Parts of the Univerſe are moveable, and are in fact in Motion, through "numberleſs little Spaces or Intervals." But what Spaces are there to move in, ſince there is "a Con-"tinuity of the whole, and a Contiguity of all "the Parts," and *no Vacuum at all* is allowed for Bodies to move in? But ſuppoſing no Difficulty in this Point, whereas it has been demonſtrably proved that there is a *Vacuum*, the Attempt to ſhew how Motion is begun and continued is remarkable. It is "by *mutual* and *mechanical* Conſent and Diſſent "of Parts that are in their *own Nature* moveable, "and by a mutual Determination of concurring "and impelling Bodies, that may be divided or "reſolved into their Elements without any *Vacuum*. "Neither is there any Intermiſſion of theſe Deter-"minations, becauſe there is *no Vacuum*, nor any "laſt Stoppage." Do the Parts of Matter, ſays Dr.

Dr. *Sykes*, that are moveable, *mutually* conſent or diſſent about their Motion?—We ſee that Matter gravitates, — that its Gravitation is always in Proportion to its Quantity; --- and it is as certain, that all *mechanical* Cauſes act in Proportion to the Superficies of the Body. How now can any Particle of Matter (even ſuppoſing it to think) give a *mechanical* Conſent to move by a Law which is not *mechanical?*

Matter is here ſuppoſed to be " in its *own Nature* " moveable, *mutually* and *mechanically* to *aſſent* to " or *diſſent* from Motion, or a certain Determina- " tion of Motion; to move through " Number- " leſs Intervals without any *Vacuum.*" If matter be in " its *own Nature* moveable," yet ſtill if it be at *reſt* it requires a *Mover* to put it into Motion. It cannot move itſelf, unleſs there be a *Motive Power* in itſelf, — Now if it has this Motive Faculty, it cannot exert it through thoſe *numberleſs Intervals*, unleſs it forces other Matter out of them, which muſt force other and other ſtill *in infinitum:* And then every minute finite Particle muſt be able to remove infinite Bodies, and to cauſe an infinite Determination of Motion, ſince there is no laſt Stoppage. —

This Univerſe is " *incorruptable*, and *neceſſary* " both Ways, *viz.* It is eternal in Exiſtence, and " will continue for ever." Our Author has very well refuted this Aſſertion by ſhewing that nothing can exiſt *neceſſarily*, the Non-exiſtence of which can be clearly and conſiſtently conceived by the Mind: And this, he obſerves, is the Caſe with all thoſe imaginary infinite Worlds which compoſe the *Pantheiſtic* Univerſe. It implies no Contradiction, as he ſays, to ſuppoſe the Earth, the Sun, or any Planet to be away, and the Space which now they fill to be left empty: And what is ſuppoſeable, without any Contradiction, to be true of any one of the Worlds of the Univerſe, is likewiſe ſuppoſeable of any, or

of

of all the reſt. —— It is quite otherwiſe with whatever exiſts by a Neceſſity in its Nature, or cannot but exiſt; the Non-exiſtence of it is not conceivable. Try the Truth of this, as the Doctor bids the *Pantheiſt*, by applying it to ſuch things as cannot but exiſt, as *Immenſity*, *Space*, or *Duration*. Suppoſe any of theſe not to exiſt; yet ſtill the Idea obtrudes itſelf upon the Mind, and we find the Thing exiſting, even whilſt we would imagine it not to be. The ſame Concluſion naturally follows from Mr. *Toland's* own Doctrine of the infinite Viciſſitudes of the Parts of the Univerſe, the periſhing of one, as he aſſerts, always giving Origin to another. Now the Parts, ſays our Author, which we ſee to be gone, may be ſuppoſed, without a Contradiction not to have been; and the things produced may likewiſe be imagined never to have been. What therefore might *poſſibly* not be, cannot be *neceſſary* in Exiſtence.

*Laſtly*, This "Univerſe is intelligent." But Dr. *Sykes* aſks the *Pantheiſts*, What is *intelligent?* Rocks? Earth? Water? Matter? Are the infinite Worlds, which make up the Univerſe, *themſelves* intelligent? or do they mean, that there is Intelligence in them? Be it as they pleaſe; how came Intelligence into the Univerſe? — To account for this, Mr. *Toland* ſuppoſes "an Etherial Fire ſurrounding all things, and "therefore ſupreme; pervading all things, and "therefore moſt intimate to them; an *Æther* I ſay "(the wonderful Fabric of the Brain being ſuited "exactly to it, and external Objects acting upon "it by the Nerves of the Senſes, and exciting va-"rious Images) performs all the Machinery of Per-"ception, Imagination, Remembrance, enlarging "or contracting Ideas."

To evince the Folly of this Hypotheſis it is ſufficient to aſk, as our Author here does, ſuppoſing there is ſuch an *Etherial Fire*, whence came that? Is that an original ſelf-exiſtent Cauſe of Things, or

is

is it derived from ſome other ſuperior Being? But next how does it appear that there is ſuch an *Æther* at all that does produce ſuch Effects? It may be allowed, as the Doctor notes, that there is a very ſubtle Spirit which pervades groſs Bodies, and that has very particular and uncommon Effects: As appears in *magnetic* and *electrical* Bodies, *&c.* — But this Spirit does not *make Intelligence*; but acts upon Beings that are *intelligent*. —— It is not God; but it was made itſelf by God. So that granting this Principle, it will not anſwer to the Idea of God, nor make the *Pantheiſtic* Scheme a *Rational* one, nor account for any of the Phænomena of Nature, without taking in that Notion, to avoid which Pantheiſm was invented.

I have here almoſt entirely ſet down what our learned Author has offered in Confutation of a plauſible Atheiſtic Syſtem; which tho,' as we here ſee, extreamly abſurd, when ſtrictly canvaſed, is well enough calculated, by its ſolemn Pretences to Antiquity and philoſophical Reaſoning, to impoſe upon the Unwary and Half-learned: And as I fear it has had too extenſive an Influence among the Gentlemen of that Claſs, who now ſwarm ſo thick every where among us, under the glorious (but uſurped) Title of Free-thinkers, I heartily wiſh this Antidote might reach as far as the Infection has proceeded.

[ *To be continued.* ]

ARTICLE

## ARTICLE XX.

THEY have lately printed, at *Geneva*, the firſt Book of Sir *ISAAC NEWTON*'s *Philoſophiæ Naturalis Principia Mathematica:* The whole illuſtrated by a continued Commentary of the Fathers *Thomas Le Seur* and *Francis Jacquier*, Profeſſors of Mathematicks, of the *French* Convent of *Minims* at *Rome.* We ſhall ſhortly have the ſecond and third Books of the *Principia*, treated in the ſame Manner, in two other Volumes. The Annotators are ſaid to have performed their Part in a very elegant and judicious Manner. They have prefaced the whole with a ſhort Account of what they have done, and of the Motives that engaged them to undertake it.

They obſerve, that all who are in the leaſt acquainted with this incomparable Author, know how abſtruſe as well as uſeful his *Mathematical Principles of Philoſophy* are. Such is the Dignity and Sublimity of the Matter, ſuch the more than geometrical Conciſeneſs of the Expreſſion, that they ſeem deſigned only for the firſt Rank of Geometers. For this Reaſon our Commentators thought they ſhould perform an acceptable Service to ſuch as are deſirous of advancing in mathematical Knowledge, and the true Science of Nature, if they explained the ſeveral Theorems, Corollaries and Scholia of this moſt excellent Syſtem, in a Manner that might render them intelligible to thoſe who are but indifferently verſed in the common Geometry and Algebra. For this End they have in their Comment, following exactly the Steps of Sir *Iſaac Newton*, demonſtrated thoſe Principles of Mechanicks and the Arithmetick of Infinites which any ways relate to their Purpoſe. They have

have likewiſe inſerted therein a Treatiſe of *Conic Sections*, that is at once very conciſe and comprehenſive.† Thoſe Particulars which by their exceſſive Obſcurity, might perplex and fatigue the Reader, they have endeavoured to expound and ſet in the cleareſt Light; and (for the Satisfaction of thoſe who will not place an implicite Faith even in Sir *Iſaac* himſelf) have ſtrictly demonſtrated thoſe Propoſitions, Scholia, and Corallories, which Sir *Iſaac* only laid down as certain Truths, omitting the Demonſtrations; and diſplayed many noble Theorems which lay hitherto concealed in thoſe invaluable Repoſitories. In the laſt Place, they have interſperſed here and there in their Annotations, certain general Problems, which are calculated, not only for improving the Readers Knowledge in the Principles of the *Newtonian* Philoſophy, but diſcovering to him the Road whereby their celebrated Author was led to the Invention of them.

† This Treatiſe was compoſed by M. *Calandrin*, Profeſſor of Mathematicks in the Univerſity of *Geneva*. This Gentleman ſuperviſed the Impreſſion of the Work before us; the Text of which he took care ſhould be exactly conformable to the Edition of the *Principia* publiſhed at *London*, 1726.

## ARTICLE XXI.

Philoſophical Tranſactions *for the Months of* Auguſt *and* September, 1738. Quarto. *With two Copper-plates. Printed for* C. Davis, *in* Pater-noſter-row, *and* T. Woodward *between the two* Temple-gates *in* Fleet-ſtreet.

This Number contains

I. AN Inquiry concerning the *Figure of ſuch Planets as revolve about an Axis*, ſuppoſing the Denſity continually to vary from the Centre towards the Surface; by Mr. *Alexis Clairaut*, F. R. S. and Member of the Royal Academy of Sciences at *Paris*. Tranſlated from the *French* by the Rev. *John Colſon*, *Lucaſian* Profeſſor of Mathematicks at *Cambridge*, and F. R. S.

II. New Experiments upon *Ice*; taken from Abbé *Nolet*, F. R. S. at *Paris*, and communicated by *J. T. Deſaguliers*, L. L. D. F. R. S.

III. An Obſervation of the *magnetic Needle* being ſo *affected* by great *Cold*, that it would not traverſe; by Capt. *Chriſtopher Middleton*, F. R. S.

IV. Extract of a Letter from Dr. *Andrew Cantwell* of *Montpelier*, to Dr. *Thomas Stack*, dated *June* 23, 1732. concerning an uncommon Palſey of the Eye-lids.

V. An Account of the Man whoſe *Arm* with the *Shoulder-blade* was torn of by a *Mill*, the 15th of *Auguſt*, 1737. by Mr. *John Belchier*, F. R. S. Surgeon to *Guy*'s Hoſpital.

VI. An Account of the *Wound*, which the late Lord *Carpenter* recived at *Brithuega*; whereby a *Bullet* remained near his *Gullet* for a *Year* wanting a few Days; communicated to the *Royal Society* by

by his Son the Rt. Hon. *George* Lord *Carpenter*, F. R. S. *&c.*

VII. Of an Obſtruction of the *biliary Ducts*, and an Impoſthumation of the *Gall Bladder*, diſcharging upwards of 18 Quarts of bilious Matter in 25 Days, without any apparent Defect in the animal Functions. By *Claudius Amyand*, Eſq; Sergeant Surgeon to his Majeſty, and F. R. S.

VIII. Some Obſervations on the preceeding Caſe, by *Alexander Stuart*, M. D. F. R. S. *&c.*

IX. The apparent Times of the *Immerſions* and *Emerſions* of the four *Satellites* of *Jupiter*, for the Year 1740. Computed to the *Meridian* of the Royal Obſervatory at *Greenwich*, by *James Hodgſon*, F. R. S.

X. The apparent Times of ſuch of the *Immerſions* and *Emerſions* of *Jupiter*'s *Satellites*, as are viſible at *London*, in the Year 1740. By the ſame.

XI. A Continuation of an Account of *an Eſſay* towards a *natural Hiſtory* of *Carolina*, and the *Bahama Iſlands*; by *Mark Cateſby*, F. R. S. with ſome Extracts out of the ninth Set, by Dr. *Mortimer*, *Secretary* to the *Royal Society*.

The firſt of theſe Articles, which conſiſts of two Parts, affords a noble Subject of Speculation. The learned Writer (who was one of thoſe ſent to the Pole, to make the curious Obſervations, for determining the Figure of the Earth, of which the ingenious M. *de Maupertuis* lately publiſhed an Account) ſays, " Notwithſtanding that Part of Sir *Iſaac Newton*'s *mathematical Principles of natural Philoſophy*, where he treats of the Figure of the Earth, is delivered with the uſual Skill and Accuracy of that great Author; yet he thought ſomething further might be done in this Matter, and that new Inquiries may be propoſed, which are of no ſmall Importance, and which poſſibly he overlooked, thro'

" the Abundance of thoſe fine Diſcoveries he was " in Purſuit of."

What at firſt appeared to M. *Clairaut* worthy of examining, when he applied himſelf to this Theory, was to know why Sir *Iſaac* aſſumed the conical Ellipſis for the Figure of the Earth, when he was to determine its Axis? For he does not acquaint us why he did it, neither can we perceive how he had ſatisfied himſelf in this Particular: And unleſs we know this, we cannot intirely acquieſce in his Determinations of the Axis of the Planets. It ſeems as if he might have taken any other oval Curve, as well as the conical Ellipſis of *Apollonius*, and then he would have come to other Concluſions about thoſe Axes.

M. *Clairaut* began with convincing himſelf by Calculation, that the Meridian of the Earth, and of the other Planets, is a Curve approaching very nearly to an Ellipſis; ſo that no ſenſible Error could enſue by ſuppoſing it really ſuch.—

The elliptical Form of the Meridian being once proved, he no longer found any Thing in Sir *Iſaac Newton*, about the Figure of the Earth, which could create any new Difficulty; and he ſhould, he ſays, have thought this Queſtion ſufficiently diſcuſſed, if the Obſervations made under the *Arctick* Circle had not prevailed on him, and the others employed, to believe, that the Shape of the Earth was ſtill flatter than that of Sir *Iſaac*'s Spheroid; and if he himſelf had not pointed at the Cauſes, which might make *Jupiter* not quite ſo flat, as by his Theory, and the Earth ſomething more.

As to *Jupiter* he ſays, (*Page* 416. of the 3d Edition of *Phil. Nat. Prin. Math.*) that its Equator conſiſts of denſer Parts than the reſt of its Body, becauſe its Moiſture is more dried up by the

the Heat of the Sun. But as to the Earth, he ſuſpects its Flatneſs to be a ſmall Matter greater than what ariſes by his Calculation. He inſinuates, that it may poſſibly be more denſe towards the Centre than at the Superficies.

M. *Clairaut* expreſſes his Surpriſe at Sir *Iſaac Newton*'s imagining, that the Sun's Heat can be ſo great at *Jupiter*'s Equator, when it has no ſuch Effect at that of the Earth; and that he does not aſcribe each to a like Cauſe, by ſuppoſing alſo, that *Jupiter* may be of a different Denſity at the Centre from that at the Superficies.

But whatever Reaſon he might have for introducing two different Cauſes, M. *Clairaut* gives the Preference to the Hypotheſis which ſuppoſes unequal Denſities at the Centre and at the Circumference.

" He has inquired, by the Aſſiſtance of this " Theory, what would be the Figure of the Earth, " and of the other Planets which revolve about an " Axis, on Suppoſition that they are compoſed of " ſimilar *Strata*, or Layers, at the Surface; but " that their variable Denſity, from the Centre to- " wards the Circumference, may be expounded by " any algebraical Equation whatſoever. And tho', as " he adds, his Hypotheſis ſhould not be conformable " to the Laws of Nature, or even though it ſhould " be of no real Uſe (which would be the Caſe, if " the Obſervations made by the Mathematicians " in *Peru*, compared with thoſe that have been " made in the *North*, ſhould require that Propor- " tion of the Axes, which is derived from Sir *Iſaac*'s " Spheroid;) he thought however, that Geome- " tricians would be pleaſed with the Speculations " contained in this Paper, as being, if not uſeful, " yet curious Problems at leaſt."

The Number of theſe Problems is ſeven, all which our Author has demonſtrated in the firſt Part of his Inquiry. In the ſecond Part, he has applied them,

them, for finding the Figure of Spheroids, which revolve about an Axis: And concludes with ſome Reflections on the Principles he has made uſe of, for the Determination of that Point.

" The only three Planets, he ſays, in which we " can be aſſured of Gravitation, and the centri- " fugal Force, are the Sun, *Jupiter*, and the Earth. " As to the Sun, the centrifugal Force is there ſo " ſmall, in reſpect of its Gravity, that his Poles " muſt be very little depreſſed, ſo that we cannot " be ſenſible of it but by Obſervation. Then as " to *Jupiter*, Obſervations make him ſomething " leſs flat than according to Sir *Iſaac Newton*; that " is to ſay, than if he were compoſed of Matter " of an uniform Denſity. Therefore by the fore- " going Theory, he muſt be a little more denſe " towards the Centre, than at the Parts near the " Superficies.——

" As to what concerns the Earth, M. *Clairaut* " ſays, he ſhall wait till we receive the Obſervations " which muſt have been lately made in *Peru*; that " by comparing thoſe with what have been made " under the *Arctick* Circle, and with thoſe of M. " *Picart* in *France*, we may have the true Diffe- " rence of the Earth's Diameters at the Equator and " at the Poles. Then his Theory may be applied, " to determine whether the Earth is more or leſs " denſe at the central Parts than at the Surface, " or whether it be every where of an uniform Den- " ſity, as it ought to be, if (without admitting very " groſs Errors in the Obſervations) it may be con- " cluded, that the Earth is really the Spheroid of " Sir *Iſaac Newton*."

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